Hrabrin Bachev

Agricultural Economics, Governance and Innovation in Bulgaria

Vol. 1

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Institute of Agricultural Economics, Bulgaria

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Preface

Despite huge progress in the theory and practice of this new area, still there is no consensus on how to assess the sustainability of agro-ecosystems due to diverse understandings, approaches, methods, employed data, etc. In Bulgaria there are practically no deep studies on sustainability level of diverse agro-eco-systems. This paper tries to fill the blank and assesses the sustainability level of agro-ecosystems of different type in Bulgaria. First a holistic hierarchical framework for assessing integral, economic, social and ecological sustainability of agro-ecosystems in Bulgaria is suggested including 17 principles, 35 criteria, and 46 indicators and reference values. After that, an assessment is made on overall and aspects sustainability of large (agro)ecosystems in North-Central, South-Eastern, South-Central and South-Western geographic regions, and particular main and specific types of agro-ecosystems of the country - mountainous, plain-mountainous, plain, riparian (Struma, Maritza, Yantra), southern Black Sea, mountainous

area with natural constraints, non-mountainous area with natural constraints, protected areas and reserves, Western Thracian Plain, Middle Danube Plain, Dupnitsa and Sandansko-Petrich Valley, Sredna Gora Mountains and Western Rila Mountains. The assessment is based on first-hand information collected though in-depth interviews with the managers of "typical" farms in the respective ago-ecosystems. The study has found out that there is a considerable differentiation in the level of integral sustainability in agricultural ecosystems of different types. Furthermore, there are substantial variations in the levels of economic, social and ecological sustainability of agro-ecosystems of different type, and the critical indicators enhancing or deterring overall and particular sustainability of individual agro-ecosystems.

Despite the greattheoretical and practical significance, in Bulgaria there are no comprehensiveanalysis of the state and evolution of agrarian research and development (ARD) activities. The goal of this paper is to analyze the state and evolution of ARD in Bulgaria during the period after country's EU accession in 2007, identify major trends in that area, make a comparison with other EU states, specify main problems, and suggest conclusions for improvement of policies during next programing period. The analysis has found out that in years of EU membership the expenditures for ARD significantly decreased absolutely and relatively as a share in the total expenditures for R&D, which indicates diminishing importance, and deteriorating financial, personnel and material potential of agrarian knowledge and innovation sector. The most important sector for ARD in the country is the government in which more than 80% of overall expenditures for ARD are invested, as distribution of expenditures and organization of R&D in major sectors differ considerably from other EU member states. ARD in the country mainly are funded by the state budget, and the

importance of budget financing relatedly increases during the period, unlike trends in other EU countries.

Despite its big theoretical and practical importance in Bulgaria there are no comprehensive analysis of the state and evolution of digitalization in agriculture and rural areas. The goal of this study is to analyze the state, development and efficiency of digitalization in the agrarian sphere in Bulgaria, specify major trends in that area, compare the situation with other EU countries, identify main problems, and make recommendation for improving policies in the next programing period. Analysis has found out that in recent years there is considerable improvement of the access of Bulgarian households to internet as well as a significant increase in the persons using internet for relations with public institutions and trading goods and services. Nevertheless, Bulgaria is quite behind from other EU members in regards to introduction of digital technologies in the economy and society taking one of the last places in EU in terms of Integral Index for Introduction of Digital Technologies in the Economy and Society – DESI. There is a great variation on the extent of digitalization in different subsectors of agriculture, farms of different juridical type and size, and different regions of the country. Most agricultural holdings are not aware with the content of digital agriculture as 14% apply modern digital technologies. Major obstacles for introduction of digital technologies are qualification of employees, amount of required investment, unclear economic benefits, and data security. Main areas where state administration actions are required are: support of measures for supplementary training of labor, tax preferences in planning of actions and digitalization of activity, stimulation of young specialists, introduction of internationally recognized processes of standardization and certification, adaptation of legislation in the area of data protection, and securing reliable and high speed networks.

Agricultural ecosystems of different types and their specific “agro-ecosystem” services are among the most widespread in the world. However, in Bulgaria the state of practical progression of the studies of agricultural services in mostly at the methodological level and very limited to general classification and qualitative “assessments”. This article tries to fill the gap and present initial results of large scale studies on mapping the sources, types and importance of agroecosystem services in Bulgaria. The identification of the type, size, efficiency and importance of “produced” services of agro-systems is based on the assessments of the managers of 324 “typical” farms of different legal status, size, production specialization, ecological and geographical location. The study has found out that there are significant differences in the participation and contribution of agricultural holdings in the protection and provision of agro-ecosystem services in the various specific and principled ecosystems of the country, and major subsectors of agricultural production. The latter requires special measures to improve, diversify and intensify this activity of farmers through training, information, exchange of experience, public incentives and support, etc. Analyzes of the structure and importance of agro-ecosystem services in the country are to be expanded by improving the accuracy and representativeness of the information by increasing the number of surveyed farms, avoiding “double” accounting, applying statistical methods to verify the reliability, special "training" of and those involved in surveys, applying direct field measurements experts and stakeholders involvement etc.

Despite its big theoretical and practical importance in Bulgaria there are no comprehensive analysis of the state and evolution of digitalization in agriculture and rural areas. The goal of this study is to analyze the state, development and efficiency of digitalization in the agrarian sphere in

Bulgaria, specify major trends in that area, compare the situation with other EU countries, identify main problems, and make recommendation for improving policies in the next programing period. Analysis has found out that in recent years there is considerable improvement of the access of Bulgarian households to internet as well as a significant increase in the persons using internet for relations with public institutions and trading goods and services. Nevertheless, Bulgaria is quite behind from other EU members in regards to introduction of digital technologies in the economy and society taking one of the last places in EU in terms of Integral Index for Introduction of Digital Technologies in the Economy and Society – DESI. There is a great variation on the extent of digitalization in different subsectors of agriculture, farms of different juridical type and size, and different regions of the country. Most agricultural holdings are not aware with the content of digital agriculture as 14% apply modern digital technologies. Major obstacles for introduction of digital technologies are qualification of employees, amount of required investment, unclear economic benefits, and data security. Main areas where state administration actions are required are: support of measures for supplementary training of labor, tax preferences in planning of actions and digitalization of activity, stimulation of young specialists, introduction of internationally recognized processes of standardization and certification, adaptation of legislation in the area of data protection, and securing reliable and high speed networks.

Despite the great theoretical and practical significance, in Bulgaria there are no comprehensive analysis of the state and evolution of the system of agricultural information, training and advices in Bulgaria. The goal of this paper is to analyze the state and evolution of the system of agricultural information, training and advices in Bulgaria during the period after country's EU accession, identify major trends in

that area, make a comparison with other EU states, specify main problems, and suggest conclusions for improvement of policies during next programing period. The analysis has found out that in years after accession of the country to EU the number of the farm managers who undertook full agricultural training increases, but despite that almost 93% of them are still with practical experiences and without any agricultural training. The extent of participation of rural areas rests weak and constantly decreasing, and Bulgaria is among the last in EU in hours of formal and informal education and training. In years of EU membership the number of provided consultations is doubled and in recent years 17% of all registered agricultural producers and each tenth farmer in the country are consulted while the subjects of provided consultation widened. Also hundreds of events associated with knowledge and innovation transfer and sharing are organized as most of them are jointly organized by the National Advisory Service with the institutes of Agricultural Academy, agrarian and other universities, research and development organizations. The number of organized events, the overall number of participants, and the average number of participant per event tend to decrease.

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20 June 2021

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1 Study on sustainability of Bulgarian agro-ecosystems

Introduction

The issue of assessment of sustainability of agricultural systems of various type is among the most topical for last decades (Bachev, 2009, 2010, 2016, 2017, 2018; Bachev *et. al.*, 2016, 2017; Candido *et al.*, 2018; FAO, 2013; Fuentes 2004; Hayati *et. al.*, 2010; Ikerd, 2015; Ivanov *et al*, 2009; Gliessman, 2016; Gemesi, 2007; Gitau *et al.*, 2009; Jalilian, 2012; Irvin *et. al.*, 2016; Lopez-Ridauira *et. al.*, 2002;Rezear *et. al*, 2018; Sauvenier *et al.*, 2005; Terziev *et al.*, 2018; Todorova & Treziyska, 2018; VanLoon *et al.*, 2005; Zvyatkova & Sarov, 2018).

Agro-ecosystems are ecosystems associated with agricultural (farming) activity and according to their specific characteristics and levels of analysis, the borders of an individual agro-ecosystem could be a part of a separate farm (e.g. a cultivated parcel, a meadow, a pond), located in numerous farms, or most commonly cover a larger region(s) of a country or beyond. Moreover, the individual agro-

ecosystem could include, be a part, or overlap with other ecosystems - dryland, mountain, coastal, urban, etc.

In recent years an "ecosystem approach" has been increasingly incorporated in the management and evaluation of sustainability levels (Bachev & Treziev, 2017, 2018; Belcher, 1999; Bohlen & House, 2009; Hanna *et. al.,* 2016; MEA, 2005; De Oliveira, 2018; Ramírez-Carrillo *et. al.,* 2018; Oelbermann, 2014; Sidle *et al.,* 2013). Despite enormous progress in the theory and practice of this new evolving area, still there is no consensus on how to assess the sustainability of agro-ecosystems due to diverse understandings, approaches, methods, employed data, etc.

In Bulgaria comprehensive sustainability assessments are mostly on sectoral (Bachev *et. al.,* 2017) or farm (Bachev, 2017; Bachev & Treziev, 2017) levels while there is practically no in-depth study on sustainability agro-ecosystems.

The goal of this paper is to assess the sustainability level of agro-ecosystems of different type in Bulgaria.

Methodology and data

In order to assess sustainability level of agro-ecosystems in Bulgaria a hierarchical system is developed including 17 principles, 35 criteria, and 46indicators and reference values. Principles are the highest hierarchical level associated with the "universal" functions of agricultural system and represent the state of sustainability in 3 main pillars (aspects) of sustainability - economic, social, and ecological. Criteria represent a resultant state when the relevant principle is realized. Indicators are quantitative and qualitative variables of different types (behavior, activity, input, effect, impact), which can be assessed allowing the measurement of compliance with particular criteria. Reference Values are the desirable levels (absolute, relative, qualitative) for each indicator according to the specific conditions of each agro-

ecosystem which assist the assessment giving guidance for achieving (maintaining, improving) sustainability.

We have examined the available academic research, official documents, and experience in Bulgaria and other countries, and have carried out numerous consultations with leading national and international experts in the area. On this basis, a system that includes principles, criteria, indicators, and reference values relevant to contemporary conditions in Bulgaria has been formulated. An expert panel was set up with ten leading experts in the country discussed and evaluated the importance of the proposed principles, criteria, indicators, and reference values, and selected most appropriate to the contemporary conditions in Bulgaria (Table 1). A number of criteria were used in selecting indicators: relevance to reflecting aspects of sustainability; discriminatory power in time and space; analytical soundness; intelligibility and synonymy; measurability, governance and policy relevance; and practical applicability (Sauvenier *et al.*, 2005).

Table 1. *System of principles, criteria, indicators, and reference values for assessing sustainability level of agro-ecosystems in Bulgaria*

Principles	Criteria	Indicators	Reference values
		Economics aspect	
Financial stability	Reducing dependence on subcidies	Share of direct payments in Gross Value Added	Experts estimate/ Trend
	Sufficient liquidity	Ratio of overall liquidity	Experts estimate/ Trend
		Ratio of quick liquidity	Experts estimate/ Trend
	Minimizing dependence on external capital	Share of owned in total capital	Experts estimate/ Average for the sector
Economic effectiveness	Positive or high profitability	Cost - effectiveness	Experts estimate/ Average for the sector
		Profitability of capital	Experts estimate/ Average for the sector
	Maximize or increase labour productivity	Labour productivity	Experts estimate/ Average for the sector
	Maximize or increase land productivity	Productivity of land	Experts estimate/ Average for the sector
	Maximize or increase	Livestock productivity	Experts estimate/

	livestock productivity		Average for the sector
Competitiveness	Support or increase of marketed output	Share of marketed output	Experts estimate/ Trend
	Support or increase of sales	Sales growth in the last 3 years	Experts estimate/ Trend
Adaptability to economic environment	Sufficient adaptability to market environment	Ratio of gross income to fixed costs	Experts estimate/ Trend
	High investment activity	Investment growth	Average for the sector/ Trend
		Social aspect	
Welfare of employed in agriculture	Equality of income with other sectors	Ratio of farm income to the average income in the region	Experts estimate/ Trend
	Fair distribution of income in agriculture	Ratio of payment of hired labour in the farm to average income in the region	Average for the sector/ Trend
	Sufficient satisfaction from farm activity	Degree of satisfaction from farm activity	Farmers assessment
	Satisfactory working conditions	Correspondence to official norms	Official norms
Conservation of farming	Preservation of the number of family farms	Existence of a heritor ready to take over of the farm	Experts estimate/ Trend
		Number of family workers	Experts estimate/ Trend
		Age of the manager	Farmers assessment/ Trend
	Increasing the knowledge and skills	Level of participation in the training programs	Experts estimate/ Trend
		Level of education of the manager	Experts estimate/ Trend
	Maintaining and increasing of agrarian education	Number of employed with special agricultural education	Experts estimate/ Trend
Gender equality	Equality in men-women relations	Degree of participation of women in farm management	Half/Trend
Social capital	Participation in professional associations and initiatives	Number of participations in professional associations and initiatives	Experts estimate
		Level of hired labour membership in labour unions	Experts estimate/ Trend
	Participation in public management	Public position	Experts estimate/ Trend
	Contribution to the development of regions and communities	Participation in local initiatives	Experts estimate/ Trend
	Sufficient ability to	Vacant job positions in	Experts estimate/

Adaptability to the social environment	respond to the ceasing farming activity and the demographic crisis	the farms to the total number of employed	Trend
		Ecological aspect	
Air quality	Maintaining and improving air quality	Growth of carbon emissions for the past three years	Trend
Land quality	Minimizingsoil losses	Soil erosion index	Scientific norm/ Trend
	Preservation and improvement of soil fertility	Amount of nitrogen fertilization	Scientific norm/ Average for the sector
		Amount of potassium fertilization	Scientific norm/ Average for the sector
		Amount of phosphorus fertilization	Scientific norm/ Average for the sector
	Maintaining a balanced land use structure	Share of arable land (without fallow) in total agricultural areas	Scientific norm/ Average for the sector
	Preservation of landscape features	Amount of area covering the requirements for "green" direct payments through maintaining landscape elements	Experts estimate/ Trend
Water quality	Maintaining and improving water quality	Index of groundwater pollution	Scientific norm/ Average for the sector
Effective energy consumption	Minimizingthe use of conventional energy	Fuel consumption per unit area	Experts estimate/ Average for the sector
		Cost of conventional electric energy per unit of gross output	Trend/ Average for the sector
Biodiversity	Maintaining or enhancing natural habitats	Change in the number of habitats	Trend/ Average for the sector
		Share of agricultural land in NATURA 2000 and other protected areas	Planed target Trend/
	Preserving and improving the biodiversity	Number of cultivated plant species	Trend/ Average for the sector
Animal welfare	Compliance with the principles ofanimal welfare	Level of compliance with the principles of animal welfare	Official norms
Implementation of organic production	Increasing the organic production	Share of areas under conversion or certified for organic production	Experts estimate/ Trend
Adaptability to the environment	Sufficient adaptability to climate change	Variation in the yield of main crops	Average for the sector/ Trend
		Death rate in livestock farms	Average for the sector/ Trend

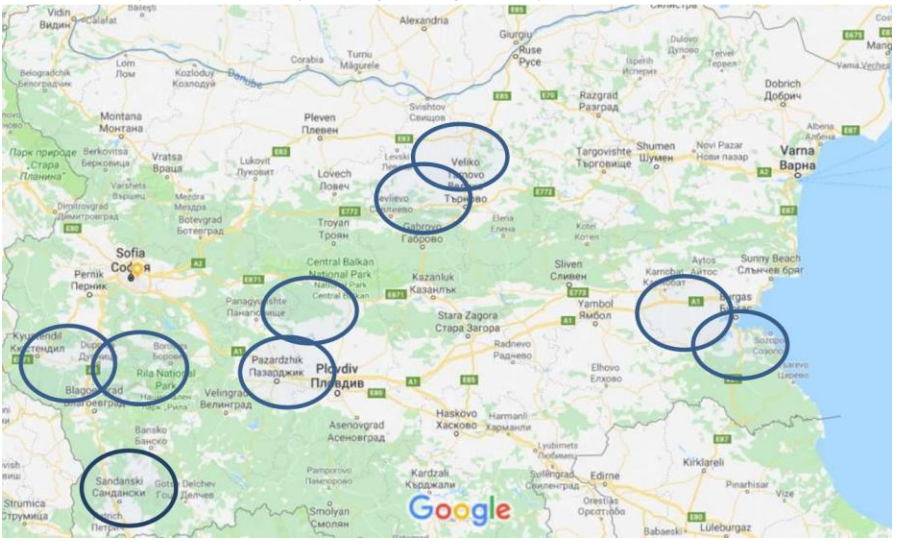
Source: Authors

In Bulgaria, such as in the most countries, there are no official data for calculating socio-economic and (some parts of) ecological indicators at agro-ecosystem level. Agro-ecosystems are the ecosystems associated with the farming activity and the individual farm is the first level for governing of agrarian sustainability (Bachev, 2018).

In order to assess the level of sustainability of agro-ecosystems in the country in-depth interviews with the managers of 80 farms of different types and locations in 4 major regions of Bulgaria were held in 2017. Following criteria were used for the selection of areas for farm surveys (Map 1):

- major administrative and geographic regions - Eastern, Northern, Western and Southern Bulgaria respectively North-Central, South-Eastern, South-Central and South-Western administrative and geographic regions of the country representing distinctive large (agro)ecosystems;

- particular main types and specific (agro) ecosystems in the country - mountainous, plain-mountainous, plain, riparian (Struma, Maritza, Yantra), southern Black Sea, mountainous area with natural constraints, non-mountainous area with natural constraints, protected areas and reserves, Western Thracian Plain, Middle Danube Plain, Dupnitsa and Sandansko-Petrich Valley, Sredna Gora Mountains and Western Rila Mountains.



Map 1. *Map of Bulgaria and surveyed agro-ecosystems*
Source: Google maps

In order to identify the "typical" for the different regions of the country farms, the co-operation of the main associations of farmers (National Association of Grain Producers, National Union of Gardeners, Union of Breeders, etc.), state agencies (National Agricultural Advisory Service, Executive Agency for Vine and Wine, etc.), processing, bio-certification and service organizations, and local government is used. Farmers of different types were surveyed covering the main types of farms in the regions concerned:different legal types of holdings - natural persons, sole traders, cooperatives, commercial companies, etc .;farms of different sizes - mainly for self-sufficiency, with small size for the sector, with average size for the sector, with large sizes for the sector;farms in different production specialization - arable crops, vegetables, flowers and mushrooms, perennials, grazing livestock, pigs, poultry and rabbits, mixed crops and mixed livestock breeding;farms in specific geographic and ecological locations.From farms originally identified for interviews only 5,61% were not interviewed

due to the extreme occupancy, unwillingness to participate or other reasons.

During the surveys, the managers of the farms were aware with the objectives of the survey, they replied to the questions prepared in advance and discussed the main problems and challenges of sustainable agriculture in the farms and eco-systems. The duration of the interview with each participant was from several hours to a whole day, and in many cases additional meetings and phone calls were conducted to refine and supplement the answers.

The survey includes many questions in 5 major areas:general characteristic of farms;primary information for calculating economic indicators for agrarian sustainability at agro-eco-system level;primary information for calculating social indicators for agrarian sustainability at agro-eco-system level;primary information for calculating environmental indicators for agrarian sustainability at agro-eco-system level; impact of diverse socio-economic, policies, behavioral, personal, etc. factors on farmers actions for improving agrarian sustainability and its various aspects.

After that diverse quantitative and qualitative levels for each indicator are transformed into a unitless index of sustainability (ISi). After than the integral index for a particular criterion (SI(c)), principle (SI(p)), and aspect of sustainability (SI(a)), and the integral sustainability index (SI(o)) for each surveyed farm is calculatedapplying equal weight for each indicator in a particular criterion, of each criterion in a particular principle, and each principle in every aspect of sustainability.

The arithmetic averages of the indices of composite indicators, criteria and principlesare calculated by the following formulas:

$SI(c) = \sum SI(i)/n$ n - number of indicators in a particular criterion;

$SI(p) = \sum SI(c)/n$ n - number of criteria in a particular principle;

$SI(a) = \sum SI(p)/n$ n - number of principles in a particular aspect,

$SI(o) = \sum SI(a)/3$

The composite sustainability index of a particular agri-ecosystem is an arithmetic average of the indices of relevant farms belonging to that agro-ecosystem.

For assessing the level of sustainability of agro-ecosystems the following scale defined by the experts is used:

Index range 0,85-1 for a high level of sustainability;

Index range0.50-0,84 for a good level of sustainability;

Index range 0,25-0,49 for a satisfactory level of sustainability;

Index range 0,12-0,24 for an unsatisfactory level of sustainability;

Index range 0-0,11 for non-sustainable.

General characteristic of the question naire farms

The survey was conducted in the period April-November 2017 and covered 80 farmers from five administrative districts of the country - Pazardjik, Plovdiv, Kjustendil, Blagoevgrad, Bourgas and VelikoTarnovo (Table 2).

Table 2. *Geographical and ecological location of agricultural holdings surveyed (number)*

	North-Central Region	South-western region		South-CentralRegion		South-eastern region	General number * and%
Location of farms	Veliko Tarnovo	Kjustendil	Blagoevgrad	Pazardzhik	Plovdiv	Bourgas	
Mostly plane area	2	4	4	14	0	8	80
Plane-mountain area	8	4	2	8	2	6	37,5
Mostly mountain area	0	6	2	4	6	0	22,5
Land in protected areas and territories	0	0	0	0	2	4	7,5
Mountain area with natural restrictions	2	6	0	4	0	2	17,5
Non-mountainous area with natural restrictions	0	0	2	2	0	0	5
Western Thracian Lowland	0	0	0	22	0	0	27,5
Middle Danube Plain	6	0	0	0	0	0	7,5
Dupnitsa valley	0	4	0	0	0	0	5
Sandanski-Petrich valley	0	0	6	0	0	0	7,5
The valley of the Maritsa river	0	0	0	14	0	0	17,5
The valley of the Yantra river	6	0	0	0	0	0	7,5
The valley of the Struma River	0	4	6	0	0	0	12,5
South-Black Sea	0	0	0	0	0	8	10
Middle Forest mountain	0	0	0	6	6	0	15
Western Rila mountain	0	4	2	0	0	0	7,5
Total number	10	14	8	26	8	14	80*
Share of all (%)	12,5	17,5	10	32,5	10	17.5	100

Source: Survey with managers of farms, 2017

The majorities of the surveyed holdings are unregistered farms of individuals, mostly small in size, and specialize in mixed plant-animal farms and perennial farms (Table 3). Most of the studied farms are located in South Central and South-West geographical and administrative regions, and in mostly plane and plane-mountain areas of the country. One quarter of the farms surveyed is in the Thracian Lowland. Each fifth is located in valleys of different kind - Danube plain, Dupnitsa valley and Sandanski-Petrich valley. In riverside ecosystems of different types (Maritsa, Struma and Yantra) there are about 36% of the farms surveyed and in the seaside area - every tenth farm.

Table 3. *Legal status, sizes and production specialization of the surveyed agricultural farms (number)*

	North-Central Region	South-western region		South-Central Region		South-eastern region	Share in total number (%)
Type of farms	Veliko Tarnovo	Kjustendil	Blagoev-grad	Pazar-dzhik	Plovdiv	Bourgas	
Legal person	6	6	2	6	6	4	37,5
Sole trader	2	4	4	6	0	0	20
Cooperative	2	2	0	4	0	4	15
Commercial company, etc.	0	2	2	10	2	6	27,5
Companies mostly for self-sufficiency	0	2	0	0	4	0	7,5
Companies rather small for the industry	4	6	2	14	2	2	37,5
Companies average for the industry	4	4	4	10	0	6	35
Companies big for the industry	4	0	2	2	2	6	20
Field crops	2	2	0	2	0	4	12,5
Vegetables, flowers and mushrooms	0	2	2	4	0	0	10
Perennial plants	4	0	4	6	2	4	25
Grazing animals	2	0	0	2	2	0	7,5
Pigs, birds and rabbits	0	2	0	2	0	0	5
Mixed plant-animal farms	2	4	2	4	4	4	25
Mixed plant farms	0	2	0	6	0	2	12,5
Mixed livestock farms	0	2	0	0	0	0	2,5

Source: Survey with managers of farms, 2017

The owners or managers of the majority of farms surveyed are men and in active working age from 41 to 65 years. Such gender and age structure of managers (owners) will manage the majority of Bulgarian farms in the near 10-15 years and will contribute to one or other level of their sustainability. The majority of respondents are between age from 56 to 65, which is an indicator of both their life and professional experience and the worrying aging of the employed in our agriculture.

Most of the farms surveyed have a relatively long life - over 15 years and only 10% with a short development period from 2 to 5 years. This is an indicator that the majority of

farms have sufficient effective management experience and sustainability. Most of the farmers surveyed indicate that the period they are taking care of improving the sustainability of the farm is over 6 years, the majority of them are in the group with long experience over 15 years. There is a correlation between the duration of the existence of the farms and the period during which the farms take care to improve their sustainability. Moreover, with the increase in the duration of the existence of the farm, the proportion of farms with an effective care to improve their sustainability increases. All this shows that the practical problem of "agrarian sustainability" is not new. However, the question is whether farms know and to what extent they respect the principles of sustainable agriculture.

The kknowledge of the main socio-economic and environmental challenges and the basic principles of sustainable agriculture is the basis for effective management of agrarian sustainability. Our large-scale survey found that according to the majority of farms in the country, they are located in areas with "normal" economic, social and environmental problems. However, a significant part of them is in the areas with "big" or "extreme" economic, social and environmental challenges. One third of the managers say that their farm is located in an area with "small" or "no" ecological problems, while the share of farms with similar economic and social problems is smaller. The share of managers who are not familiar with the character or cannot assess the level of socio-economic and environmental problems in the area where their farm is located is not low.The greatest concern is farmers' competence with regard to the ecological problems in the area, followed by social and economic challenges.

Our study found that the majority of the managers of the surveyed farms know "well" and "very well" the principles of economic, social and environmental sustainability. At the

same time, a large proportion of farmers recognize that their knowledge of the principles of social and environmental sustainability is "satisfactory" or lacking at all. The low lack of competence concerns almost half of the holdings in terms of social sustainability principles, almost every third farm in terms of environmental sustainability and about one fifth of farms for economic sustainability.

Only a small proportion of the farms surveyed increase their sustainability management capacity by hiring a consultant, and this is all about getting to know the principles of environmental and economic sustainability. The relatively high (internal) potential for managing the different aspects of sustainabilityare cooperative farms, where everyone knows "well" or "very well" the principles of economic and social sustainability, and a significant part of them know the principles of environmental sustainability (Figure6). At the same time, 16.67% of these farms "use a consultant" to improve their environmental sustainability competence.

All of the sole traders know well or very well the principles of economic sustainability and three-quarters of them - the principles of environmental sustainability. About 12% of thesetypes of farms hire a consultant in order to improve the economic sustainability. The majority of sole traders also know well or very well the principles of social sustainability. However, 37.5% of them report that their knowledge about the principles of social sustainability is not good. The majority of commercial companies know well or very well the principles of economic and environmental sustainability, but only slightly more than half of them have a similar level of competence with respect to the principles of social sustainability. Every tenth of this type of farms also use an external consultant to enhance its environmental sustainability competence. Two thirds of individuals are highly competent in terms of economic sustainability

principles, and 40% of them are also competent in terms of environmental sustainability. At the same time, nearly three quarters (73.33%) of this type of farms are not well aware of the principles of social sustainability.

Competence of sustainability principles grows together with farm size and, as a rule, larger farms are better acquainted with economic, social and environmental sustainability. At the same time, 7.69% of medium-sized farms hire a consultant to increase their knowledge of economic sustainability and 15.38% of environmental sustainability. At the same time, it is worrying that none of the farms that are primarily for self-sufficiency know well the principles of economic, social and environmental sustainability. This group of producers represents a significant part of all farms in the country and is an important factor in improving the socio-economic and environmental sustainability of agriculture. There is also a differentiation of competence with respect to the principles of sustainability and depending on the production specialization of farms. In all categories of farms, a high level of knowledge of the principles of economic sustainability is typical of all or a majority of them. Exceptions are only farms with plant breeding specialization, where each second farm is not well aware with the principles of economic sustainability. Half of pig, poultry and rabbit farms also have a consultant to improve their competence in terms of economic sustainability.

Knowledge of the principles of ecological sustainability is high in farms specializing in field plants, perennial crops, mixed crops, mixed crops and grazing livestock, while in farms with other specialization the share of those with low ecological competence is significant. Each fifth offield plants farms improves their ecological sustainability capacity by hiring a consultant, similar to 11.11% of those in perennial crops. Knowing the principles of social sustainability

isgoodin most of the farms specializing infield plants, mixed plant growing and perennial crops. For farms in other production specialization, the share of highly competence in social sustainability is low, and for farms with vegetables, flowers and mushrooms, and those in mixed livestock farming, their share is zero.

Farms located in predominantly plain and plain-mountain areas and those in non-mountainous areas with natural constraints have a better knowledge of the principles of economic, social and environmental sustainability. On the other hand, farms located in predominantly mountainous areas, in mountainous areas with natural constraints and those with landscapes in protected areas and territories have a relatively small part highly competence in the principles of sustainability. Some of the farms located in mountainous regions improve their economic and ecological sustainability by employing a consultant - respectively 6.67% and 13.33% of all farms in this group.

Finally, all the farms surveyed in the South-East region know well or very well the economic, social and ecological principles of agrarian sustainability. Competencefor economic sustainability is high in most of the farms in the other studied regions of the country. Most of the farms in the North-Central region are well informed about environmental sustainability while in the South-West region they are a minority. Also, knowing the principles of social sustainability is not good at the majority of farms in the South-Central and South-West regions of the country. Consultants in order to improve the knowledge of sustainable agriculture use 13.5% and 6.25% of farms in the South-West and South-Central region in terms of ecological aspects and 6.25% of farms in the South Central Region in terms of economic sustainability.Therefore in the future, greater efforts should be made in order to improve the farmers' competence in low-culture groups with regard to

the principles of agrarian sustainability through training, counselling, advices, exchange of positive experiences, etc.

Competence about the principles of agrarian sustainability is necessary but not a sufficient condition for its effective management. Due to incomplete knowledge and various other economic, technological, agronomic, behavioural, etc. reasons, and at different times, farmers do not always strictly apply the principles of sustainable agriculture. Our study found that, according to the majority of farm managers, they comply "strict" or "good" principles of economic, ecological and social sustainability (Bachev 2016). However, a significant part of the farms respect the principles of social, economic and environmental sustainability only "satisfactory". Moreover, some farms point that they do not "follow" such principles (which reach 6% of the total number of farms in terms of social sustainability), or "only follow if there are sanctions" (up to 8% ecological sustainability).

The principles of agrarian sustainabilityare applied to the greatest extent in the general management of farms in cooperatives and commercial companies. Around 8% of cooperatives apply the principles of environmental sustainability only if there are sanctions. A comparatively smaller proportion of sole traders and natural persons apply the principles of social sustainability to a high degree. Many natural persons follow the principles of sustainable agriculture only if there are sanctions - 9% for environmental sustainability, 5% for economic sustainability and 5% for social sustainability. These data show that sanctions by the state, local authorities, owners, members, etc. generate economic behaviour to improve environmental sustainability in certain groups of farms such as cooperatives and natural persons.

The application of sustainability principles grows with farm sizes and as a rule, larger farms are better of economic,

social and environmental sustainability.Compliance with the diversity of sustainability principles is the most common among farms specializing in field plants, grazing livestock and mixed plant breeding and mixed plant growing farms. However, the quoted study also found that for all groups of holdings, the proportion of those who respect well or strictly the principles of agrarian sustainability exceeds the proportion of those who know well or very well these principles. Therefore, the question is how much some of the farms apply effective principles that they themselves do not know well.

Overall level of sustainability in analyzed agro-ecosystems

The multi-indicatorassessment of agricultural sustainability level in the four analyzed regions shows that the integral indicator of overall sustainability is 0,58, which expresses a good sustainability level of agriculture (Figure 1). The biggest value has the indicator of economic sustainability (0,64), the social sustainability shows lower value (0,57) and the ecological sustainability is close to the unsatisfying value level (0,53). Therefore, the improvement of the last two indicators is critical for maintaining the good agricultural sustainability of the country.

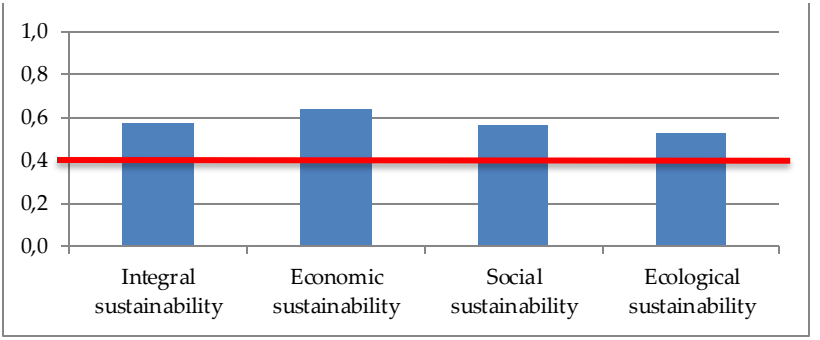


Figure 1. *Indicators of integral, economic, social and ecological sustainability of analyzed agri-ecosystems in Bulgaria*
Source: Survey with managers of farms, 201 7 and author's calculations

The analysis of private indexes on basic principles, criteria and indicators of the sustainability gives opportunity to identify components contributing for the levels of different aspects of agricultural sustainability in the country. The assessment ascertained that the ecological sustainability is relatively low due to the fact that the indicators for the principles "land quality" (0,44), "biodiversity" (0,38) and "organic production" (0,11) are low (Figure 2). Thus, the improvement of these low levels of above-mentioned principles is a factor for maintenance and raising of ecological and integral sustainability in the sector. Also it becomes clear that despite the relatively high integral economic sustainability, the indicator of adaptability to economic environment is relatively low (0,54) and critical for maintaining the reached level. Analogically, for the social sustainability improvement would contribute mostly the increase of low levels of indicators for the principles "farming conservation" (0,52), "gender equality" (0,40) and "social capital" (0,17).

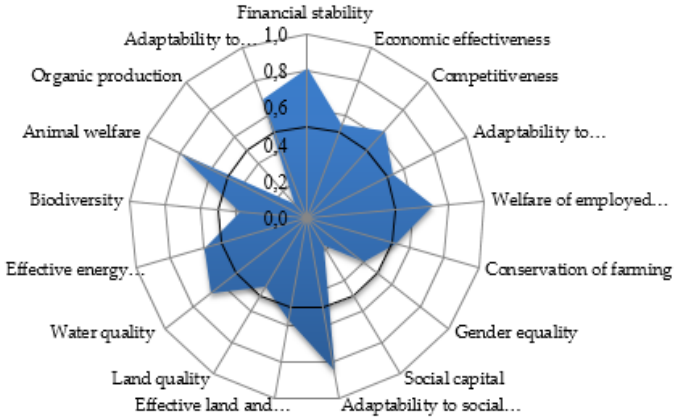


Figure 2. *Sustainability index according the main sustainability principles in analyzed agri-ecosystems in Bulgaria*
Source: Survey with managers of farms, 201 7 and author's calculations

The profound analysis according different criteria and indicators gives opportunity for detailed analysis of elements contributing for/or decrease the agricultural sustainability level. For example, the low levels of ecological sustainability are determined from the low criteria "conservation and improving of soil fertility" (0,46); "balanced land use structure maintenance" (0,35; "landscape elements conservation" (0,30); "natural biodiversity maintenance and improvement" (0,46); "cultural biodiversity maintenance and improvement" (0,29) and "organic production increase" (0,11) (Figure 3). The unsatisfying levels according these criteria for ecological sustainability are (pre)determined of low levels of indicators for eco-sustainability, as: insufficient conformity of norms for fertilization with potassium (0,38) and phosphorus (0,38), high share of arable land in the total agricultural land (0,33), low degree of compliance with practices for landscape conservation (0,3), insufficient protected species on farms' territory (0,18), limited number of cultural species in farms

(0,29) and low degree of application of organic production principles (0,11) (Figure 4).

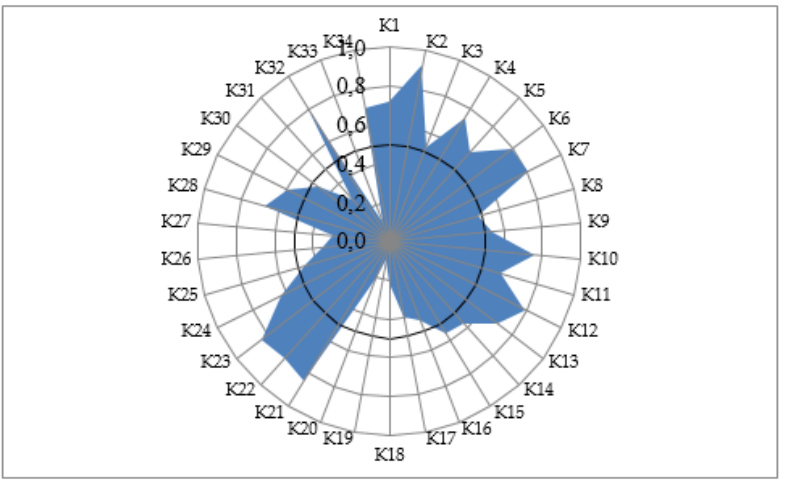


Figure 3. *Sustainability index according the main criteria* in analyzed agri-ecosystems in Bulgaria*

Notes: * K1-Decrease of dependence on subsidies; K2-Minimization of dependence on exterior capital; K3-Positive or high profitability; K4-Maximal or increasing labour productivity; K5-Maximal or increasing land productivity; K6-Maximal or increasing livestock productivity; K7-Conservation or increase of sold output share ; K8-Conservation or increase of sales; K9-High investment activity; K10-Incomes parity with other sectors; K11-Equitable distribution of income in agriculture; K12-Sufficient satisfaction of farmer activity; K13-Satisfying labour conditions; K14-Keeping the number of family farms; K15-Knowledge and skills increase; K16-Conservation and improvement of agricultural education; K17-Equality of relations man-woman; K18-Participation in professional organizations and initiatives; K19-Participation in public management; K20-Contribution for the development of region and communities; K21-Sufficient potential for reaction to activity cession and to demographic crisis; K22-Keeping or increase of UAA size; K23-Keeping or increase of livestock number; K24-Minimization of soil losses; K25-Keeping and improvement of soil fertility; K26-Keeping of balanced land-use structure; K27-Protection of landscape elements; K28-Keeping and improvement of water quality; K29-Minimization of conventional energy use; K30-Keeping and improvement of natural biodiversity; K31-Keeping and improvement of cultural biodiversity; K32-Implementation of principles of animal welfare; K33-Organic production increase; K34-Sufficient adaptability to climatic changes.

Source: Survey with managers of farms, 2017 and author's calculations

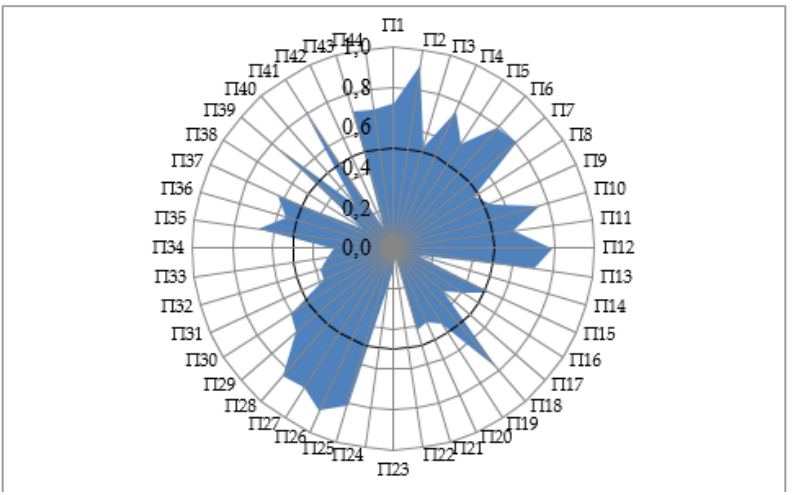


Figure 4. *Indicators* for sustainability in analyzed agro-ecosystems in Bulgaria*

Notes: *П1-Direct payments in the net income; П2-Share of own capital in the total one; П3-Profit/production costs; П4-Labour productivity; П5-Land productivity; П6-Livestock productivity; П7-Share of sold production in the total one; П8-Sales growth in the last three years; П9-Investments growth in last 5 years; П10-Net farmer's income/ average income in the region; П11-Payment of hired labour/ average income in the region; П12-Degree of satisfaction from farmer's activity; П13-Degree of compliance to normative labour conditions; П14-Presence of a family member ready to take the farm; П15-Number of family members working in the farm; П16-Age of manager; П17-Participation of training programs in the last 3 years; П18-Education level of manager; П19-Share of occupied with special agricultural education / qualification; П20-Degree of participation of women in the farm management; П21-Number of participation in professional organizations and initiatives; П22-Share of hired workers, members of trade unions; П23-Public positions occupied from the farmer, manager and owner; П24-Participation in local initiatives; П25-Share of non-occupied permanent work positions in the total number of employed; П26-Share of non-occupied seasonal work positions in the total number of employed; П27-Change of UAA in last 5 years; П28-Change of livestock number in last 5 years; П29-Soil erosion; П30-Compliance of nitrate fertilization to norms; П31-Compliance of potassium fertilization to norms; П32-Compliance of phosphorus fertilization to norms; П33-Share of arable land in the total UAA; П34-Keeping the practices of landscape maintenance; П35-Degree of pollution of underground waters with nitrates; П36-Level of fuel consumption; П37-Level of electricity consumption; П38-Presence of protected species on the farm territory; П39-Natural biodiversity protection; П40-Number of cultural species; П41-Respecting of animal welfare norms; П42-Implementation of principles for organic production; П43-Yield variation of main crops for 5 years; П44-Percentage of mortality of livestock for 5 years.

Source: Survey with managers of farms, 2017 and author's calculations

Social sustainability in agriculture is usually decreased almost by: lack of family member, ready to continue the farm work (for individual and family farms) (0,13), elderly age of managers and farm owners (0,41), insufficient participation in training programs in the last years (0,33), low share of employed with special agricultural education and qualification (0,44), insufficient participation of women in the farm management (0,4), low participation of farms in professional organizations and initiatives (0,43), lack of membership of hired workers in trade unions (0), weak participation in the public governance from the side of farmers, managers and owners (0,1), and insufficient involvement of farms in local initiatives (0,2).

Critical for the keeping and improvement of the sector's economic sustainability are the increase of production profitability (0,52) and the keeping and increase of sales (0,48). The low levels of indicators for sustainability show also the specialized areas for agricultural sustainability improvement through adequate change of farms strategies and/or of public policies in relation to the sustainable development of the sector, of different sub-sectors, ecosystems and farms types. On the other hand, the high levels of some indicators express the absolute and relative advantages of Bulgarian agriculture regarding the sustainable development. On the actual stage they are expressed in: high share of own capital in the total capital of farms (0,92), high share of sold production in the total output (0,81), lower share of non-occupied permanent (0,81) and seasonal (0,88) work places in the total number of employed, increase of UAA (0,82) and livestock number (0,84) in the last years and respect of norms for animal welfare (for the livestock breeding farms) (0,8).

Level of agricultural sustainability in the main types of agro-ecosystems

Our assessment determined that there is a considerable differentiation of the levelof integral and aspect sustainability in agricultural ecosystems main types (Figure 5). The highest integral sustainability has the agriculture in the plane regions (0,63), which have also the highest economic sustainability, with the ecosystems in protected zones and territories (0,74). On the other hand, the integral sustainability in mountain regions with natural restrictions is the lowest (0,56). These ecosystems' type has also the lowest (and close to the limits of satisfying level) levels for social sustainability, with the ecosystems in non-mountain regions with natural restrictions (0,52). Nevertheless, the ecological sustainability of agro-systems in mountain areas with natural restrictions is relatively high (0,58).

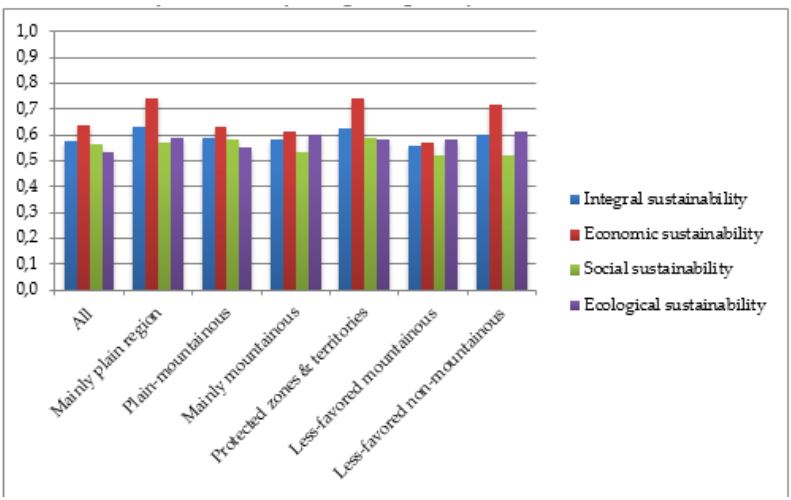


Figure 5. *Level of sustainability in the main types of agro-ecosystems in Bulgaria*

Source: Survey with managers of farms, 2017 and author's calculations

The integral sustainability of mountain ecosystems is on a medium level (0,58), but while its economic and social aspects are below the average for the country (respectively 0,61 and 0,53), the level of ecological sustainability is among the highest (0,6). The agricultural sustainability in the protected zones and territories is above the average for the country (0,62), these ecosystems having relatively high economic sustainability (0,74; the highest level of social sustainability (0,59) and good levels for ecological sustainability (0,58). the ecological sustainability in the plane-mountainous regions is the lowest in the country (0,55), and for the non-mountainous regions with natural restrictions it is the highest (0,61).

The agriculture of ecosystems in the plane regions has high significances for economic sustainability for the indicators: share of own capital in the total capital (0,96), labour productivity (0,84), livestock productivity (0,9) and share of sold production in the total output (0,89) (Figure 6). The social sustainability of the sector in these regions is high in relation to degree of correspondence to the normative labour conditions (0,84), education level of manager (0,94) and share of unoccupied seasonal labour positions in the total number of employed (0,87). Agriculture in such regions is with ecologically strong sustainability for the dynamics of UAA in the last 5 years (0,83), the dynamics of the raised livestock number In the last 5 years (0,83) and keeping the norms of animal welfare (1).

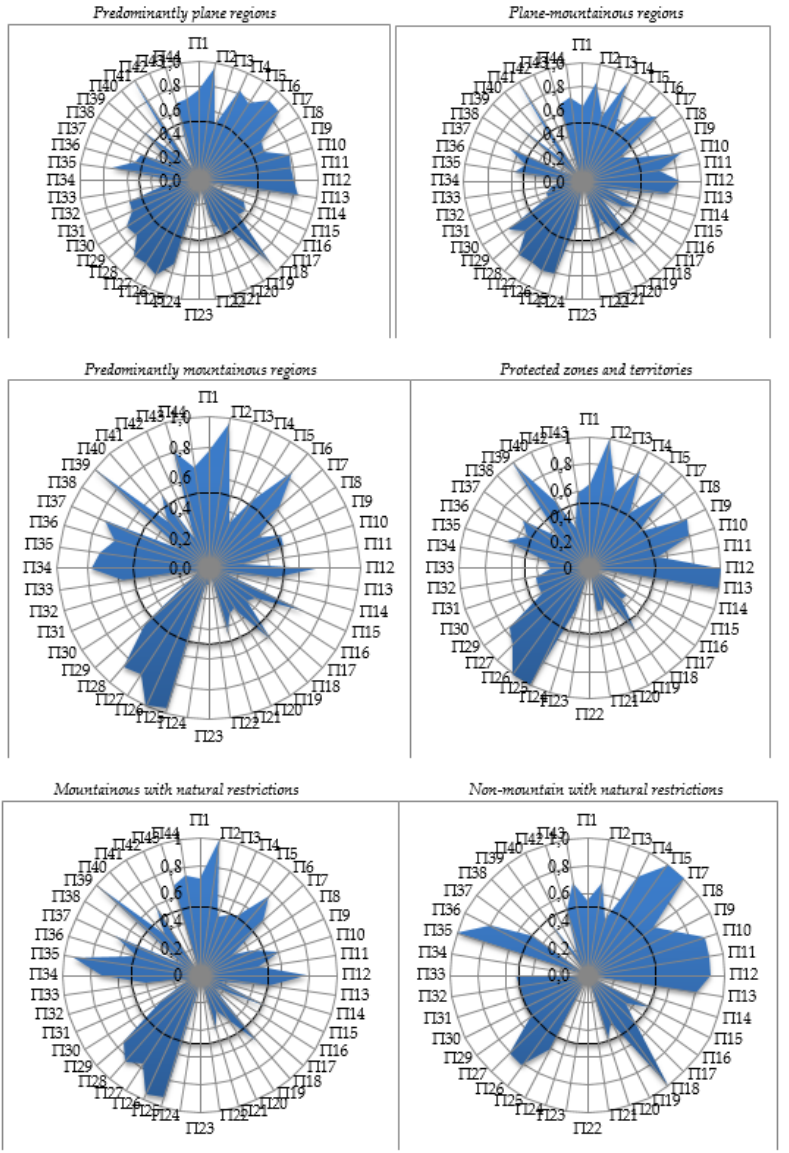


Figure 6. *Indicators for in the main agro-ecosystems types in Bulgaria*
Source: Survey with managers of farms, 2017 and author's calculations

Simultaneously, the levels of some indicators in the plane agro-ecosystems have low levels. While the economic sustainability is satisfying only regarding the relation profit/

production costs (0,49), for the social sustainability satisfying are the levels for number of family members working in the farm (0,42), manager's age (0,47), participation in training programs in the last 3 years (0,44), share of employed with special agricultural education/ qualification (0,47) and number of participation in professional organizations and initiatives (0,31). Along with that, regarding the public position of the farmer, manager or owner (0,19) and participation in local initiatives (0,13) the state is unsatisfying and for presence of family member ready to take the farm (0,06), on the limit of the unsustainability. Moreover, according the indicator share of hired workers, members of trade unions, the state is unsustainability. The ecological sustainability of the sector in these regions is satisfying in relation to the share of arable land in the total agricultural land (0,32), presence of protected species on the farm territory (0,25) and number of cultural species (0,27); and unsatisfying for the keeping of practices for landscape maintenance (0,19) and implementation of principles for organic production (0,11).

In ecosystems of plane-mountain regions the economic sustainability of agriculture is high regarding the: share of own capital in the total (0,84), labour productivity (0,91) and share of sold production in the total output (0,84) (Figure 6). The highest in social aspect in these regions are the indicators: net farm income/ average income in the region(0,87), degree of satisfaction from the farming activity (0,83), share of non-occupied permanent work positions in the total number of employed (0,81) and share of unoccupied seasonal work positions in the total number of employed (0,83). From ecological aspect, the best of these ecosystems are only the dynamics of the number of livestock in the last 5 years (0,82) and the keeping of normsof animal welfare (1).

At the same time agro-ecosystems in the plain-mountainous regions have satisfying values of economic

sustainability for the growth of sales in the last 3 years (0,38) and investments growth in the last 5 years (0,49). The social sustainability in these regions is on satisfying levels in relation to manager's age (0,37), degree of participation of women in the farm management (0,33) and participation in local initiatives (0,33); unsatisfying regarding the presence of family member, ready to take the farm (0,2) and participation in training programs in last 3 years (0,2); and socially unstable for the share of hired workers, members of trade unions and public positions of the farmer, manager or owner. In the plane-mountain ecosystems the ecological sustainability is satisfying regarding the compliance with the normsof the fertilization with potassium (0,32), compliance with the norms of phosphorus fertilization (032) and share of arable land in the total agricultural land (0,26); unsatisfying for the keeping of practices for landscape maintenance (0,13), presence of protected species on the farm territory (0,07), and number of cultural species (0,24); and unstable for the implementation of principles for organic production.

The agricultural sustainability in ecosystems in mountain regions has the highest values for the economic indicators: share of own capital in the total capital (0,97) and livestock productivity (0,84); the social indicators of the share of non-occupied permanent work positions in the total number of employed (0,97), and share of unoccupied seasonal work positions in the total number of employed (1); and ecological indicators: dynamics of UAA in last 5 years (0,83), dynamics of raised livestock in last 5 years (0,86), natural biodiversity protection (1), and yield variation of the main crops for 5 years (0,81) (Figure 6).In mountain regions with satisfying values for sustainability are the economic relation profit/ production costs (0,49), labour productivity (0,33), and sales' growth in last 3 years (0,38). The social sustainability of this type of ecosystems is satisfying in lots of indicators: degree of compliance with normative labour conditions (0,44),

manager's age (0,37), participation in training programs in last 3 years (0,33), share of employed with special agricultural education/ qualification (0,31), degree of participation of women in the farm management (0,33), and number of participations in professional organizations and initiatives (0,44). Furthermore, the social sustainability is unsatisfying in relation to the payment of hired labour/ average income in the region (0,22), presence of a family member, ready to take the farm (0,11), public position of the farmer, manager or owner (0,11), and participation in local initiatives (0,11). In relation to the share of hired workers, members of trade unions, there is a social instability. In the mountain agro-ecosystems the ecological sustainability is on a satisfying level for the number of cultural species (0,41), and unsatisfying for the compliance with the norms of nitrate fertilization (0,17), compliance with the norms for potassium fertilization (0,08), compliance of phosphorus fertilization with the norms (0,08), presence of protected species on the farm territory (0,22), and implementation of principles for organic production (0,22).

The ecosystems' agricultural sustainability in the protected zones and territories is economically high regarding the share of own capital in the total one (1), labour productivity (0,85), share of sold production in the total output (0,83), and investments' growth in the last 5 years (0,84) (Figure 6). This ecosystem type has strong social stability for the degree of satisfaction of the farming activity (1), degree of compliance with the normative labour conditions (1), share of unoccupied permanent work positions in the total number of employed (1), and share of non-occupied seasonal work positions in the total number of employed (1). In ecological aspect the agricultural sustainability in the protected zones and territories is high only regarding the dynamic of UAA in last 5 years (0,83), and natural biodiversity protection(1).On the other hand, the

economic sustainability of agro-ecosystems with protected zones and territories is satisfying for the sales' growth in the last 3 years (0,47), while for the livestock productivity there is an instability. The social sustainability in these zones and territories is on satisfying level in relation to manager's age (035), participations in training programs in last 3 years (0,33), degree of participation of women in the farm management (0,33), number of participations in professional organizations and initiatives (0,33), and participation in local initiatives (0,33). For the social indicators the number of family members working in the farm (0,2), and share of employed with special agricultural education/ qualification (0,24) the sustainability level is unsatisfying. Moreover, regarding the presence of family member ready to take the farm, the share of hired workers, members in trade union and the public position of the farmer, manager or owner, the ecosystems are unsustainable. In protected zones andterritories some ecological indicators are also relatively low (unsatisfying): compliance to norms of the fertilization with potassium (0,42), compliance to norms of the fertilization with phosphorus (0,42), share of arable land in the total agricultural land (0,3), keeping of practices for landscape maintenance (0,33), presence of protected species on the farm territory (0,33) and implementation of principles for organic production (0,33).

Agricultural sustainability in ecosystems of mountain regions with natural restrictions are highly economically sustainable just in relation to the share of own capital in the total (1); strongly socially sustainable for the share of unoccupied permanent work positions in the total number of employed (0,93) and share of unoccupied seasonal work positions in the total number of employed (0,96); and highly ecologically sustainable according the dynamics of livestock number in last 5 years (0,84),degree of pollution of underground waters with nitrates (0,93) and protection of

natural biodiversity (1) (Figure 6).At the same time, some economic indicators of sustainability in these ecosystems are on satisfying level, as: profit/ production costs (0,45), labour productivity (0,48), sales' growth in last 3 years (0,29), and investments' growth in last 5 years (0,43). Similarly, the social sustainability of this ecosystems' type is satisfying regarding: payment of hired labour/ average income in the region (0,43), share of employed with special agricultural education/ qualification (0,38), degree of participation of women in the farm management (0,29) and number of participations in professional organizations and initiatives (0,43). The level of social sustainability in such regions is unsatisfying for presence of family member, ready to take the farm (0,14), manager's age (0,19), participation in training programs in last 3 years (0,14) and participation in local initiatives (0,14). In relation to the share of hired workers, members of trade unions and public position of manager, farmer and owner, the mountain regions with natural restrictions are socially unsustainable. In these regions some indicators for ecological sustainability have satisfying levels, as the compliance to norms of the nitrate fertilization (0,32), share of arable land in the total agricultural land (0,4), level of fuel consumption (0,49) and number of cultural species (0,4). The ecological sustainability is unsatisfying for the compliance to the norms of potassium fertilization (0,11), compliance to norms of phosphorus fertilization (0,11) and presence of protected species on the farm territory (0,14), while for the principles of organic production implementation, they are unsustainable.

The agricultural sustainability in the non-mountain regions with natural restrictions is economically high regarding the labour productivity (0,81), land productivity (1) and share of sold output in the total one (1) (Figure 6). In relation to the social sustainability, the indicators are high for: net farm income/average income in the region (0,9),

payment of hired work in the region (0,9), degree of satisfaction from the farming activity (0,9), education level of manager (1) and share of unoccupied seasonal work positions in the total number of employed (0,81).The ecological sustainabilityin these regions is high only for the pollution of underground waters with nitrates (1).The agro-ecosystems in the non-mountain regions with natural restrictions have satisfying economic sustainability only regarding the ratio profit/ production costs (0,43). The social sustainability of these agro-ecosystems is satisfying for the age of manager (0,34) and share of employed with special agricultural education/ qualification (0,38). As regards to the presence of family member ready to take the farm; number of participation in professional organizations and initiatives; share of hired workers, members of trade unions; public position of farmer, manager or owner and participation in local initiatives, these ecosystems are unsustainable. Non-mountain regions with natural restrictions have unsatisfying level of ecological sustainability for the indicator number of cultural species (0,15) and they are ecologically unsustainable as regards the keeping of landscape maintenance practices (0) and presence of protected species on the farm territory. (0).

Level of agricultural sustainability in the specific agro-ecosystems

In the fourth geographical regions of the country have been identified and analyzed the following important for the respective region and for the country, as a whole, agro-ecosystems: the ecosystems alongside the rivers Yantra, Maritsa and Struma, West Thrace valley, Middle Danube plane, Doupnitsa and Sandanski-Petrich hollows, South- cost Black sea, SashtinskaSredna Gora and West Rila mountain.

The assessment postulated that there is a big variation in the levels of integral, economic, social and ecological sustainability of agriculture in the specific ecosystems. From the analyzed 10 agro-ecosystems, the highest integral sustainability has Sandanski-Petrich hollow (0,61), with economic sustainability with highest values (0,73), social sustainability with also high values (0,61), while the ecological sustainability is among the lowest in the country and on satisfying level (0,47) (Figure 7).On the other hand, the integral sustainability of agriculture in Dupnitsa hollow is on the lowest level (0,49) and the only one with satisfying level among the analyzed ecosystems. In this ecosystems the levels of social (0,45) and ecological (0,45) sustainability are satisfying and the lowest among the analyzed.

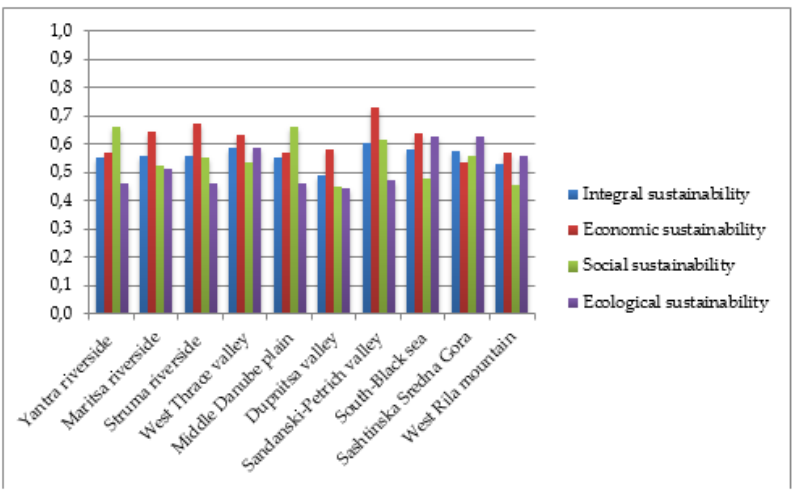


Figure 7. *Levels of sustainability in the specific agro-ecosystems in Bulgaria*

Source: Survey with managers of farms, 2017 and author's calculations

The integral sustainability of agro-ecosystems in the areas alongside the rivers Yantra, Maritsa and Struma is on a relatively low (under the average) level – respectively 0,55, 0,56 и 0,56. However, there is a big differentiation of

different aspects of sustainability in these specific ecosystems. For the eco-system alongside Struma river the economic sustainability is on a high level (0,67), while for Yantra riverside it is slightly below the average for the country. On the other hand, the area alongside Yantra has the highest level of social sustainability (0,66), whereas the area alongside Maritsa has the lowest social sustainability and close to the limit of the satisfying level (0,52). For the three riverside ecosystems the ecological sustainability of the sector is below the average values for the country, as for Maritsa riverside the value is on the border of the satisfying level (0,51), and for the other riverside ecosystems – on satisfying level (by 0,46).

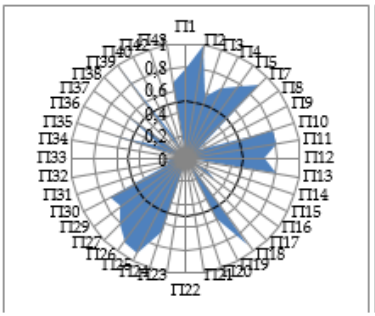
The agro-ecosystem Middle Danube plain has relatively low integral sustainability (0,55), with levels of social sustainability among the highest in the country (0,66), and from ecological aspect on the satisfying level (0,46) and among the lowest for the country. The agriculture in the West Thrace valley has integral sustainability on a relatively high level and over the average for the country (0,59). This agro-ecosystem has good economic sustainability, over the average (0,67), with one of the highest levels of ecological sustainability (0,59), but relatively low and under the average social sustainability (0,54).

Both analyzed specific mountain agro-ecosystems have lower integral sustainability than the average – respectively 0,57 for SashtinskaSredna Gora, and 0,53 for West Rila mountain. The social (0,56) and the ecological (0,63) sustainability of SashtinskaSredna Gora are higher than the values of West Rila mountain (respectively on satisfying level 0,46 and good level 0,56), whereas for the economic sustainability is the opposite (0,53 and 0,57). SashtinskaSredna Gora and South Black sea cost have the highest indicators for ecological sustainability among all analyzed specific ecosystems in the country. The integral

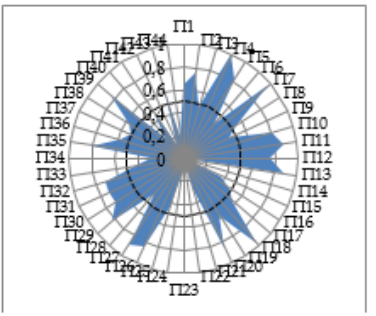
sustainability of agriculture of South Black seais on the average level for the country - 0,58, while the economic sustainability is on a middle level (0,64), the social sustainability is satisfying (0,48), and the ecological is the best of all analyzed (0,63).

There is a considerable variation of different indicators' levels in the specific agro-ecosystems. Three specific riverside ecosystems in North Central, South Central and South-West regions were analyzed. In the agro-ecosystem of Yantra river high levels have only the indicators for economic sustainability – share of own capital in the total one (1) and share of sold production in the total output (0,91); the indicators for social sustainability – level of education of the manager (0,93), number of participations in professional organizations and initiatives (1),share of unoccupied permanent work positions in the total number of employed (0,93), and share of unoccupied seasonal work positions in the total number of employed (0,9); and for the ecological sustainability – natural biodiversity protection (1) (Figure8).

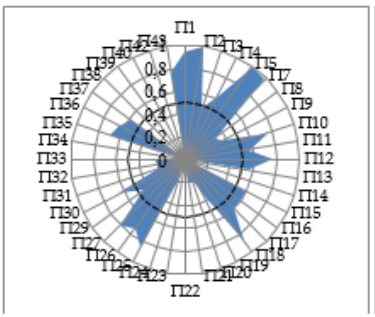
Yantra riverside



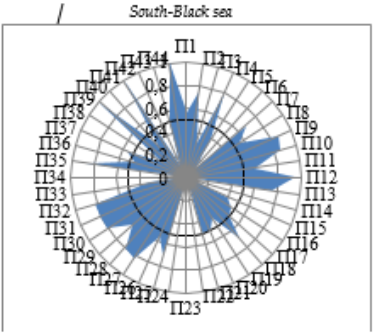
Maritsa riverside



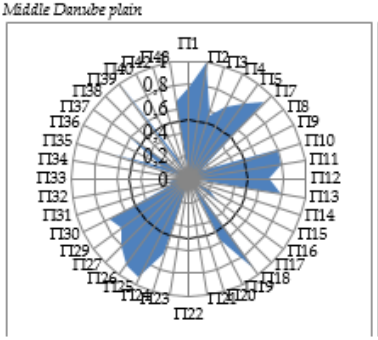
Struma riverside



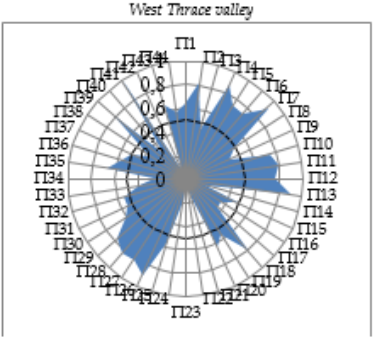
South-Black sea



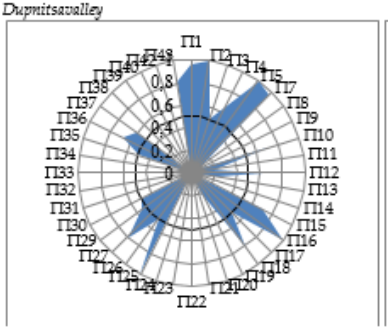
Middle Danube plain



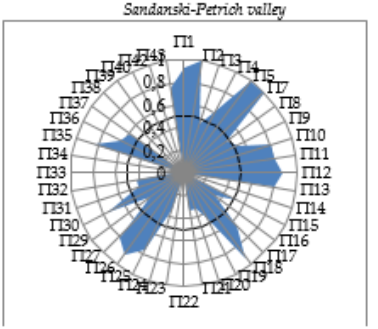
West Thrace valley



Dupnitsavalley



Sandanski-Petrich valley



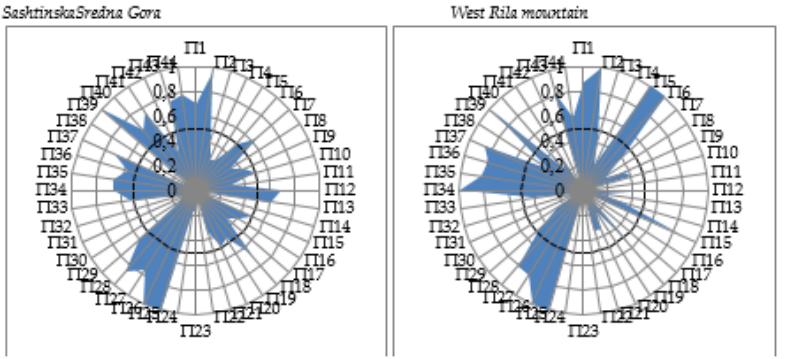


Figure 8. *Indicators for sustainability in the specific agro-ecosystems in Bulgaria*

Source: Survey with managers of farms, 2017 and author's calculations

The agriculture of Yantra riverside has unsatisfying sustainability for lots of indicators: economic growth of sales in the last 3 years (0,13) and investments' growth in the last 5 years (0,2); social number of family members, working in the farm (0,2); and ecological: compliance of potassium fertilization to the norms (0,17), compliance to the norms of phosphorus fertilization (0,17), level of fuel consumption (0,25) and number of cultural species (0,2).Moreover, this system is unsustainable due to lots of social and ecological indicators: presence of a family member, ready to take the farm; participation in training programs in last 3 years; degree of participation of women in the farm management, share of hired workers, members of trade unions; public position, occupied by the farmer, manager or owner; share of arable land in the total agricultural land; keeping of practices for landscape maintenance; presence of protected species on the farm territory; implementation of principles for organic production. In relation to the age of manager, the social sustainability is satisfying (0,32). Similar to indicators of the agro-ecosystem along Yantra riverside are the indicators for the sustainability of Middle Danube plain.

The agriculture in the other analyzed riverside ecosystem, of Maritsa, is characterized by several indicators for levels of high sustainability: economic – labour productivity(1), land productivity (0,81) and share of sold production in the total production (0,98); social – payment of hired labour/average income in the region (0,88), degree of compliance to normative labour conditions (0,88), education level of the manager (0,97), degree of participation of women in the farm management (0,86), share of unoccupied seasonal work positions in the total number of employed (0,84); and ecological – dynamics of UAA in the last 5 years (0,88), soil erosion (0,83), degree of pollution of underground waters with nitrates (0,81) and natural biodiversity protection (0,86) (Figure 8).

The agro-ecosystems from the riverside of Maritsa have satisfying sustainability of economic indicators: profit/ production costs(0,48), livestock productivity(0,4) and investments' growth in the last 5 years(0,43). The level of social indicators is also satisfying: number of family members, working in the farm (0,36), manager's age (0,48), number of participations in professional organizations and initiatives (0,29) and share of unoccupied permanent work positions in the total number of employed (0,44). Similar is the level of ecological indicators: dynamics of the arable land in the last 5 years (0,4) and share of arable land in the total agricultural land (0,44).The agricultural sustainability alongside Maritsa river is on unsatisfying level about the social and ecological indicators: participation in local initiatives (0,14), keeping of practices for landscape maintenance (0,29), number of cultural species (0,24), implementation of principles for organic production (0,14) and percentage of mortality of the livestock for 5 years (0,2). In relation to social dimensions there is a state of unsustainability: presence of family member ready to take the farm, share of hired workers, members in professional

organizations and public position of the farmer, manager or owner.

Unlikely the other two riverside agro-ecosystems, this of Struma river has high economic levels of sustainability for the share of direct payments in the net income (0,94), share of own capital in the total one (1), land productivity (1) and share of sold production in the total output (0,99) (Fig.16). The social sustainability in this agro-ecosystem is high only regarding the education level of the manager (0,88) and share of unoccupied work positions in the total number of employed (0,86). On the other hand, some indicators of economic sustainability in this agro-ecosystem have satisfying levels, as: profit/ production costs (0,47), growth of sales in the last 3 years (0,32) and investments' growth in the last 5 years (0,36). Similar is the level of sustainability regarding the social and ecological indicators for the employed with special agricultural education/qualification (0,34), soil erosion (0,44)and share of arable land in the total agricultural land (0,28).

Moreover, the agricultural sustainability of Struma riverside is unsustainable in relation to the social measurers: degree of participation of women in the farm management (0,2), number of participation in professional organizations and initiatives (0,2) and participation in local initiatives (0,2); and ecological indicators: compliance to the norms of potassium fertilization (0,25), compliance to the norms of phosphorus fertilization (0,25)and number of cultural species (0,12). This agro-ecosystem is socially unsustainable in relation to the participation of a family member, ready to take the farm; share of hired workers, members in trade unions and public position of the farmer, manager or owner. The ecosystem is also in state of ecological unsustainability regarding the keeping of practices for landscape maintenance, presence of protected species on the farm

territory, protection of the natural biodiversity and implementation of principles of organic production.

The agricultural sustainability in the South-Black sea ecosystem has high levels for the economic indicator - investments' growth in the last 5 years (0,88) and for the social indicators: net farm income /average income in the region (0,85) and degree of satisfaction from farming activity (0,95) (Figure .10). The agro-ecosystem is also ecologically sustainable with lots of indicators: dynamics of UAA in the last 5 years (0,82), compliance to the norms of nitrate fertilization (0,81), compliance to the norms of the potassium fertilization (0,81),compliance to the norms of the phosphorus fertilization (0,81), degree of pollution of underground waters with nitrates (0,87), natural biodiversity protection (1), keeping the norms of animal welfare (1) and percentage of mortality for the livestock for 5 years (1).The agro-ecosystem South-Black sea has satisfying sustainability concerning the economic indicator profit/ production costs (0,31); several social indicators, as: number of family members working in the farm (0,4), manager's age (0,47) and share of employed with special agricultural education/ qualification (0,47); and ecological indicators for: share of arable land in total agricultural land (0,31), level of fuel consumption (0,47) and number of cultural species (0,37).

This specific ecosystem has unsatisfying sustainability of agriculture regarding the economic aspect for livestock productivity (0,11) and from ecological aspect: for the presence of protected species on the farm territory (0,25) and implementation of organic production principles (0,12). The agriculture of South-Black sea is socially unsustainable regarding the presence of a family member ready to take the farm; share of workers, members of trade unions; public position of the farmer, manager or owner and participation in local initiatives, and in ecological aspect, for the keeping of practices for landscape maintenance.

The agriculture in the West Thrace valley has high economic sustainability regarding the indicators share of own capital in the total one (0,82), labour productivity (0,88) and share of sold production in the total (0,92); high social sustainability for compliance to the normative labour conditions (0,89) and share of unoccupied seasonal work places in the total number of employed (0,89); and high ecological sustainability for the dynamics of UAA in the last 5 years (0,82),dynamics of the livestock number in the last 5 years (0,82), natural biodiversity protection (0,82), and keeping of norms for animal welfare (1) (Figure 10).The agriculture of this ecosystem has satisfying levels of economic sustainability for: profit/ production costs (0,44)and investments' growth in the last 5 years (0,4); social sustainability for: number of family members working in the farm (0,48), manager's age (0,36), participation in training programs in last 3 years (0,36); and ecological sustainability for: share of arable land in the total agricultural land (0,4), keeping of practices for landscape maintenance (0,27), presence of protected species on the farm territory (0,36) and number of cultural species (0,3).

The social sustainability is unsatisfying for indicators: presence of family member ready to take the farm (0,18), number of participations in professional organizations and initiatives (0,18) and participation in local initiatives (0,18), and regarding the share of hired, members of trade unions, and public position of farmer, manager or owner the state is unsustainable. The same state has the ecological sustainability regarding the implementation of principles for organic production (0,09).

In the South-West region of the country have been analyzed two specific agro-ecosystems of Dupnitsa valley and of Sandanski-Petrich valley. Dupnitsa valley has high economic sustainability of indicators: share of direct payments in the net income(0,95), share of own capital in the

total one (1), land productivity (1) and share of sold output in the total (0,97) (Fig.16). The agriculture in this ecosystem has high social and ecological sustainability only regarding the age of the manager (1),share of unoccupied permanent work positions in the total number of employed (1) and variation of yields of the main crops for 5 years (0,81).

Under two economic, several social and one ecological indicator, the sustainability of this agro-ecosystem is unsatisfying: sales growth in last 3 years (0,1), investments' growth in last 5 years (0,1), payment of hired labour/average income in the region (0,2), degree of compliance to normative labour conditions (0,22), and share of employed with specific agricultural education/qualification (0,2), and number of cultural species (0,1). Under many social and ecological indicators the level is unsustainable: presence of a family member ready to take the farm; degree of participation of women in the farm management; number of participations in professional organizations and initiatives; share of hired workers, members of trade unions; public position of the farmer, manager or owner; participation in local initiatives; compliance to the norms of potassium fertilization; compliance to the norms of phosphorus fertilization; respecting of practices for the landscape maintenance; presence of protected species on the farm territory; protection of natural biodiversity and implementation of organic production principles.

Other analyzed agro-ecosystem is Sandanski-Petrich valley, which is characterized by high sustainability of economic indicators: share of direct payments in the net income (0,93), share of own capital in the total (1), land productivity (1)and share of sold output in the total output (1); social measurers: degree of satisfaction from farm activity (0,86), education level of manager (0,93) and share of unoccupied seasonal work positions in the total number of employed (0,9); and ecological indicator: degree of pollution

of underground waters with nitrates (0,83).In this ecosystem the agricultural sustainability has relatively low (satisfying) economic sustainability according two indicators: profit/ production costs (0,45) and growth of sales in the last 3 years (0,47). Similarly, the social sustainability in the agro-ecosystem has satisfying levels in relation to: manager's age (0,33);share of employed with special agricultural education/ qualification (0,44);degree of participation of women in the farm management (0,33); number of participation inprofessional organizations and initiatives (0,33) and participation in local initiatives (0,33). The agriculture in this area is socially unsustainable regarding the presence of a family member, ready to take the farm; share of hired workers, members of trade unions and public position of the farmer, manager or owner.

Apart this, the ecological sustainability of Sandanski-Petrich valley is satisfying for the soil erosion(0,37); compliance to norms of potassium fertilization(0,42) and compliance to norms of phosphorus fertilization (0,42); unsatisfying regarding the share of arable land in the total agricultural land (0,1) and number of cultural species (0,13); and ecologically unsustainable regarding the keeping of practices for landscape maintenance; presence of protected species on the farm territory; protection of natural biodiversity and implementation of organic production principles.

Two mountain agro-ecosystems have been analyzed – SashtinskaSredna Gora and Western Rila mountain. The agriculture in SashtinskaSredna Gorais economically sustainable regarding the share of own capital in the total (0,96); strongly socially sustainable for the share of unoccupied permanent work positions in the total number of employed (1) and share of unoccupied seasonal work positions in the total number of employed (1); and highly ecologically sustainable for the dynamics of the livestock

number in the last 5 years (0,85) and for the natural biodiversity protection (1) (Figure 8).The agricultural production in this ecosystem has satisfying levels of many economic and social indicators: profit/production costs (0,43), labour productivity (0,27), land productivity (0,3), sales growth in last 3 years (0,33), investments growth in last 5 years (0,43), payment of hired labour/average income in the region (0,3), manager's age (0,41), participation in education programs in last 3 years (0,33), share of employed with special agricultural education/qualification (0,45) and number of participations in professional organizations and initiatives (0,33).This agro-ecosystem has satisfying ecological sustainability in relation to the implementation of organic production principles(0,33).

Moreover, according several social and ecological indicators the agriculture in SashtinskaSredna Gora is with unsatisfying sustainability: public position of the farmer, manager or owner (0,17), participation in local initiatives (0,17), compliance to norms of the nitrate fertilization (0,17), compliance to norms of the potassium fertilization (0,12), compliance to norms of the phosphorus fertilization (0,12). This agro-ecosystem is socially and ecologically unsustainable in relation to the presence of a family member, ready to take the farm; share of hired workers, members of trade unions and presence of protected species on the farm territory.

The other mountain agro-ecosystem Western Rila mountain has high economic sustainability in relation to the share of direct payments in the net income (0,87), share of own capital in the total (1), land productivity (1) and livestock productivity (1) (Figure 8). The social sustainability is strong regarding the indicators: number of family members working in the farm (0,86), share of unoccupied permanent work positions in the total number of employed (1) and share of unoccupied seasonal work positions in the

total number of employed (1).The agriculture in Western Rils mountain is ecologically sustainable for the respecting of practices for landscape maintenance (1), degree of pollution of underground waters with nitrates (0,83), level of consumption of electricity (0,87), protection of natural biodiversity (1) and variation of yields of main crops for 5 years (0,83).This agro-ecosystem has satisfying economic sustainability in relation to profit/production costs (0,43), share of sold output in the total output (0,41) and investments growth in last 5 years (0,37). The level of social sustainability is satisfying for the net farm income/average income in the region (0,4), presence of a family member, ready to take the farm (0,33), degree of participation of women in the farm management (0,33) and number of participation in professional organizations and initiatives (0,33). The agricultural sustainability is unsatisfying regarding the economic indicators labour productivity (0,22) and sales growth in the last 3 years (0,2); and social indicators degree of compliance to normative labour conditions (0,15) and share of employed with special agricultural education/ qualification (0,2). Furthermore, some social indicators in this agro-ecosystem have unsustainability levels: payment of hired labour/average income in the region, manager's age, participation in education programs in the last 3 years, share of hired workers, members in trade unions, public positions of the farmer, manager or owner, participation in local initiatives.

The agro-ecosystem Western Rila mountain has satisfying ecological sustainability for: soil erosion (0,46), share of arable land in the total agricultural land (0,42), presence of protected species on the farm territory (0,33) and respecting the norms for animal welfare (0,33). The ecological sustainability of the ecosystem is unsatisfying for: compliance to norms of nitrate fertilization (0,25), number of cultural species (0,23), compliance to norms of potassium

fertilization (0,08) and compliance to norms of phosphorus fertilization (0,08). This ecosystem is ecologically unsustainable in relation to the principles of organic production.

Sustainability contribution of different sub-sectors of agricultureand type of farms

Our analysis allows toassess the contribution of different sub-sectors and farms with different specialization to the total agricultural sustainability and its main aspects. The highest integral sustainability has shown by the mixed livestock-breeding (0,7) and mixed crop-growing (0,66) farms, followed by the perennial crops farms (0,63). (Figure 9). Therefore, the mixed livestock-breeding and crop-growing farms and the farms with perennials contribute in highest degree for improving the integral sustainability of Bulgarian agriculture. From the other hand, the farms specialized in pigs, poultry and rabbits (0,53); vegetables, flowers and mushrooms (0,54) and mixed livestock-crops (0,54) have the lowest integral sustainability. This means that the last mentioned types of farms decrease in a biggest degree the integral sustainability in the country.

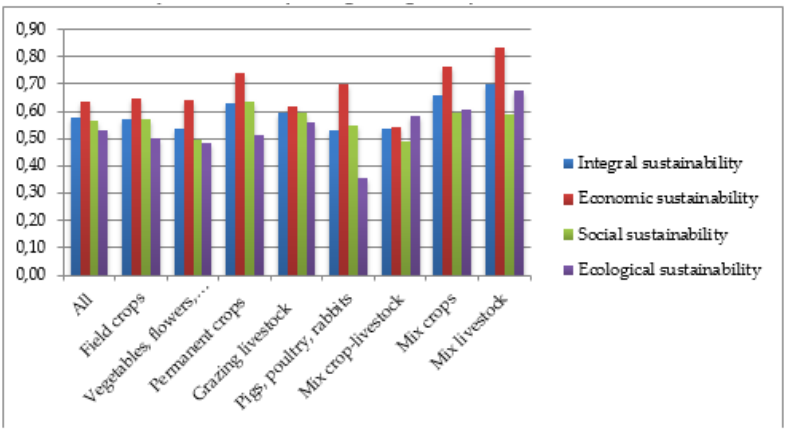


Figure9. *Sustainability contribution of different sub-sectors of agriculture in Bulgaria*

Source: Survey with managers of farms, 2017 and author's calculations

Similar to integral sustainability, the sub-sectors with the highest economic sustainability are: mixed livestock breeding (0,84), mixed crop growing (0,76) and perennial crops (0,74). The mixed crop-growing production has the highest ecological sustainability (0,61) and one of the best social sustainability (0,6). The perennial crops sector has high social sustainability (0,64), but lower than the average and almost satisfying ecological sustainability (0,51). The social sustainability of farms specialized in grazing livestock has comparatively high level of social sustainability (0,6). The social sustainability in mixed crop-livestock farms has satisfying level (0,49). The pigs, poultry and rabbits' farms have lowest and satisfying level (0,35), like the farms for vegetables, flowers and mushrooms (0,48). The field crops farms have good, but relatively low ecological sustainability (0,5), close to the satisfying level.

Furthermore, the different agricultural sub-sectors are characterized by important variation of levels of sustainability indicators and therefore type of contribution to

overall and aspect level of sustainability of agri-ecosystems in the country.

Similarly, the agricultural sustainability in different farm types has different levels, which is determined by the specific contribution of different farms for the formation of the existing level of sustainability in the agri-ecosystems of country.

Among the farms with different juridical status the trade associations show the highest agricultural sustainability (0,67), contribution the most for the agricultural sustainability of the country.In these organizational and management structures the economic (0,8) and ecological (0,63) aspects of agricultural sustainability have the highest levels, while the social sustainability is on average for the country level (Figure 10). The social sustainability is highest for sole traders (0,63), whose integral (0,65) and economic (0,77) sustainability is on the second place and are close to the values of the trade associations.

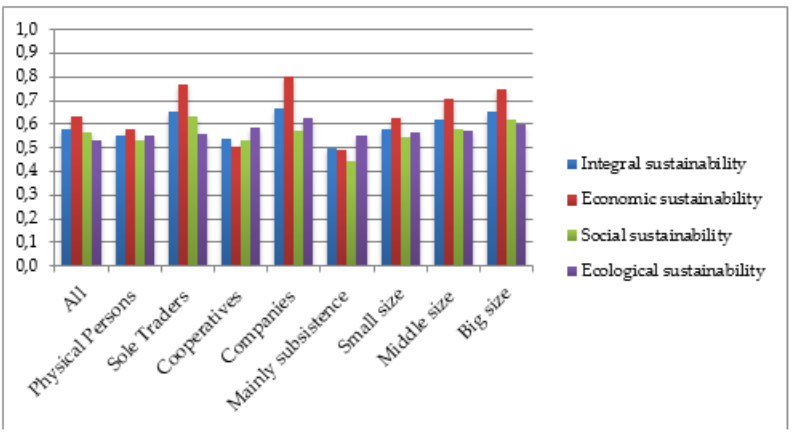


Figure10. *Sustainabilitycontribution of farms of different types in Bulgaria*

Source: Survey with managers of farms, 2017 and author's calculations

The agricultural production in cooperatives has the lowest integral sustainability (0,54), which economic sustainability (0,51) is on the border with the satisfying level, and the social sustainability is the lowest, the same level as for individuals (0,53). The cooperatives have ecological sustainability of the production on relatively high level (0,59). The agricultural production of individuals has integral sustainability under the average level (0,55) with lower than the average for the economic (0,58) and social (0,53) sustainability.

The agricultural sustainability in farms with different market orientation and sizes is also characterized by different levels and contribution to the integral agricultural sustainability in the country (Figure10). The highest integral sustainability is shown by the large farms (0,65), having the highest economic (0,75), social (0,62) and ecological (0,6) sustainability. Therefore, these farms contribute in biggest degree for the increase of the integral level of agricultural sustainability in the country.In predominantly self-subsistence farms the agricultural sustainability if low, close to the satisfying level (0,5). In these farms all the aspects of agricultural sustainability have low levels, in comparison to the large and market oriented farms, as the economic (0,49) and social (0,45) sustainability are satisfying. There is a trend to decrease of the levels of integral, economic and social sustainabilitywith the decrease of the farm sizes. The ecological sustainability of farms with small and medium sizes has the same levels, which are lower than of the bigger farms, but higher than the levels of self-subsistence farms.

The individual indicators for sustainability of farms of different juridical kind, size and market orientation are very differentiated demonstrating different type of contribution of overall and aspect sustainability of respected agro-ecosystems.

Comparison of assessment of agrarian sustainability with the previous studies in the area

Finally, we compare the integral agrarian sustainability based on the assessment of sustainability of agro-ecosystems with the results of previous studies assessing agrarian sustainability with the aggregate sectoral (statistical, etc.) data in Bulgaria (Bachev *et al.*, 2017).

According to the precious study based on aggregate data using the same methodological approach the integral sustainability index of the Bulgarian agriculture is 0.58 which correspond to a Good sustainability. That study has found out that the Economic sustainability of the Bulgarian agriculture is Good (index of sustainability 0.7), while the Social and the Environmental sustainability are also as Good but with a lower index (for both of them is 0.53) close to satisfactory level.

Therefore, integral assessment results based on the micro agro-ecosystems (farm) data are similar with the results based on aggregated sectoral (statistical, etc.) data. It means that both approaches are reliable and could be simultaneously used for assessing agrarian sustainability at various level – sector, subsector, region, agro-ecosystem, and farm.

Factors for improving sustainability of agro-ecosystems in Bulgaria

Diverse social, economic, market-related, ideological, and personal factors stimulate or restrict the activities of farming in terms of sustainable operation and development.

According to the managers surveyed, factors encouraging farming enterprises to improve economic sustainability include: market demand and price; direct state subsidies; market competition; financial capability; participation in

public support programs; possibility of benefitting immediately; possibility of benefitting in the near future; tax preferences; possibility of benefitting in the long term; and integration with buyers of farm products. Factors considered critical by a smaller proportion of enterprises include: regional community initiatives and pressure; social recognition of individual contribution; pressure and initiatives of interest groups; immediate benefits for other people and groups; and professional training for managers and hired labor.

Factors encouraging the enhancement of social sustainability for the greatest number of farms include: personal convictions and satisfaction; social recognition of individual contribution; immediate benefits for other people and groups; regional community initiatives and pressure; access to advisory services; European Union policy; and existing regional problems and risks. For a small number of enterprises, important factors encouraging social sustainability include: state control and sanctions; existence of long-term contracts with the state; registration and certification of products and services; tax preferences; and integration with suppliers.

Factors encouraging environmental sustainability include: problems and risks existing at the global scale; official regulations, standards, and norms; existing regional problems and risks; and European Union policies. Significant factors encouraging ecological sustainability for a small number of enterprises include: integration with suppliers; tax preferences; existence of long-term contracts with the state; market demand and price; integration with buyers; market competition; initiatives and pressure from interest groups; partners available for cooperative activities; initiatives of other farmers; and the possibility of garnering immediate benefits.

These motives need to be examined in relation to the modernization of public policy and the establishment of programs for sustainable development of agro-ecosystems in Bulgaria.

This survey has found that current public policies and diverse instruments of public support that improve the economic sustainability of farming enterprises in Bulgaria include: direct area-based payments; national top-ups for products and livestock; modernization of agricultural holdings; green payments; support for semi-market farms. Measures that could considerably improve the economic sustainability of a small number of holdings include: afforestation and restoration of forest; restoration and development of residential areas; stimulation of rural tourism; and the provision of services to residents of rural areas.

The impact that national and European policies have on the social and environmental sustainability of Bulgarian farming enterprises is relatively weak. Instruments that could augment the social sustainability of the majority of farming enterprises include: strategies for local development; the provision of services to residents of rural areas; restoration and development of residential areas; and stimulation of rural tourism. The social sustainability of a small number of holdings could be improved by ecological measures such as: payments for Natura 2000; agricultural environmental payments; and greater support for organic farming.

The most important actions to improve the environmental sustainability of farming enterprises include: green payments; support for organic farming; obligatory standards, norms, rules, and restrictions; and agro-environmental payments. Public instruments that would have the least impact on ecological sustainability of Bulgarian farming enterprises at the current stage of

development include: support for setting up micro-enterprises; establishing produce organizations; support for semi-market farms; diversification into non-agricultural activities; support for young farmers; and restoration and development of residential areas

There is a difference shown between individual instruments of public policy and their impact on the sustainability of farming enterprises of different types and agro-eco-systems. Mechanisms and instruments of national and European policy with the greatest impact in improving the sustainability of Bulgarian farming enterprises include:

1) Obligatory standards, norms, rules, and restrictions in terms of the governance of big enterprises and the environmental sustainability of enterprises specializing in pigs, poultry, and rabbits. 2) Direct area-based payments to improve the economic sustainability of: sole traders, cooperatives, companies, holdings of small size for their sector; enterprises specializing in pigs, poultry, and rabbits, mixed crops, and permanent crops; and enterprises located in non-mountainous regions with natural handicaps, those with land in protected zones and territories, the majority of those in mountainous regions, mountainous regions with natural handicaps, and those in the southwest and south-central regions of the country. 3) National top-ups for products and livestock to improve the economic sustainability of: companies, holdings predominantly for subsistence, and those specializing in grazing livestock; the majority of those in mountainous regions, those with land in protected zones and territories, and those located in the north-central and southwest regions of the country; 4) Green payments to improve the economic sustainability of enterprises located in mountainous regions, those with land in protected zones and territories, and those in the southwest region of the country. 5) Professional training and advice for large enterprises. 6) The modernization of

agricultural holdings to improve the economic sustainability of: sole traders and companies; those specializing in mixed livestock and mixed crops; and those located in mountainous regions and in the north-central and south-central regions.7) Support for semi-market farms and the establishment of produce organizations to improve the economic sustainability of holdings predominantly for subsistence.8) Natural handicap payments to farmers in mountainous areas to improve the economic sustainability of farming enterprises located in such areas.

All these data on the the real impact that individual mechanisms and instruments of public support have on different aspects of sustainability among Bulgarian farming enterprises need to be taken into account when seeking to improve policies and programs supporting agricultural sectors and enterprises of diverse types and agro-ecosystems.

Conclusion

This first in kind assessment on sustainability of agro-ecosystems in Bulgaria let make some important conclusions about the state of their sustainability, and recommendations for improvement of managerial and assessment practices.

Elaborated and experimented holistic framework gives a possibility to improve general and aspects sustainability assessment. That novel approach has to be further discussed, experimented, improved and adapted to the specific conditions and evolution of agro-ecosystems of different types as well as needs of decision-makers at various levels – farmers, interests groups, government officials, policy-makers, etc.

There is a considerable differentiation in the level of integral and aspects sustainability in agricultural ecosystems of analyzed main and specific types. With the highest integral sustainability are the agro-ecosystems plane regions

and Sandanski-Petrichhollow while least sustainable are agro-ecosystems mountain regions with natural handicaps and Dupnitsa hollow. Furthermore, there are substantial variations in the levels of economic, social and ecological sustainability of agro-ecosystems of different type. What is more, individual indicators with the highest and lowest values show (critical) factors enhancing and deterring particular or overall sustainability of evaluated agro-ecosystem.

Results on the integral agrarian sustainability level of this study based on the micro agro-ecosystem (farm) data are similar to the previous assessment based on the aggregate sectoral (statistical, etc.) data.

Factors that encourage farming enterprises to improve economic sustainability include: market demand and price; direct state subsidies; market competition; financial capability; participation in public support programs; the possibility of benefitting immediately; the possibility of benefitting in the near future; tax preferences; the possibility of benefitting in the long term; and closer integration with buyers. Factors that encourage enhanced social sustainability include: personal convictions and satisfaction; social recognition of individual contributions; immediate benefits for other people and groups; regional community initiatives and pressure; access to advisory services; policies European Union; and existing regional problems and risks. Factors that encourage farming enterprises to increase environmental sustainability include: problems and risks existing at the global scale; official regulations, standards, and norms; existing regional problems and risks; and European Union policies. All these incentives have to be taken into account in planning the modernization of public policy and programs for sustainable development.

National and European mechanisms of regulation and support that affect the economic sustainability of the

majority of Bulgarian farming enterprises include: direct area-based payments; national top-ups for products and livestock; modernization of agricultural holdings; green payments; and direct support for semi-market farms. The impact of national and European policies on the social and environmental sustainability of Bulgarian farming enterprises is relatively weak.

There are large differences in the impact of socio-economic, institutional, behavioral, international, natural, etc. factors and individual public policy instruments on the sustainability of farming enterprises of different types and agro-ecosystems.

Having in mind the importance of holistic assessments of this kind for improving agrarian sustainability, farm management and agrarian policies, they are to be expended and their precision and representation increased. The latter requires a closer cooperation betweenand participationof all interested parties as well as improvement of the precision through enlargement of surveyed farms, and incorporating more "objective"data from field tests and surveys, statistics, expertise of professionals in the area, etc.

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2 Agrarian research and development in Bulgaria during EU membership

Introduction

The Rapid development and modernizationof research and innovation sphere in general, and in agriculture in particular, has been an important priority ofthe EU policies in the last decades. "Stimulation and sharing of knowledge, innovation and digitalization" have been defined as one of the strategic (a "horizontal") objectives of the European Union (EU) Common Agricultural Policy (CAP) during the next 2021-2027 programing period as well (European Commission, 2018). Agrarian research and development activity is an important part of the knowledge sharing and innovationsystem[1] in that important sector of European economy contributing toachievement of all strategic goals of EU CAP.

[1]The concept of "Agricultural Knowledge Sharing and Innovation System" or AKIS has been increasingly used in academic literature and policy documents alike in recent years (EIP-AGRI; EUSCAR).

In other EU and non-EU countries there have been carried profound analyses of the state and evolution of agrarian research and development systems (Anandajayasekeram & Gebremedhin, 2009; Antle *et al.*, 2017; Chartier *et al.*, 2015; FAO, 2019; Touzard *et al.*, 2015; Mykhailova *et al.*, 2018; Özçatalbaş, 2017; USDA, 2019; Weißhuhn, 2018; World Bank, 2006; Virmani, 2013). However, in Bulgaria with very few exceptions (Башев и Михайлова, 2019; Bachev & Labonne, 2000; Bachev & Mihailova, 2019) there are no comprehensive studies on the state and evolution of agrarian research and development activity before and since the accession of the country to EU in 2007. The latter is a consequence both of the lack of sufficient official statistical, report etc. data as well as public interest in development of that important system.

This paper tries to analyze the state and evolution of agrarian research and development activity in Bulgaria during the EU membership years. The goal is to specify major trends, make a comparison with other EU states, identify main challenges, and assist policies during the next programing period[2].

Personnel and expenditures for agrarian research and development

Agrarian Research and Development (ARD) includes "every creative work, undertaken systematically, and aiming at increasing the body of knowledge, including knowledge about human, culture and society, as well as utilization of that body of knowledge in new applications" (NSI). It encompasses fundamental and applied research and experimental works.

[2] In fact, that analisis is being used for identifying public intervention needs and measures in the 2021-2027 Program for Agrarian and Rural Development of Bulgaria (Иванов, Башев и др., 2020).

ARD in Bulgaria is mostly carried out by public organizations – research institutes and experimental stations of Agricultural Academy, some institutes of Bulgarian Academy of Sciences (Institute of Plant Physiology and Genetics, Institute of Economic Studies, etc.), some of public and private universities (Agrarian University, Trasia University, Russe University, Forestry University, University of National and World Economy, High School for Agribusiness and Regional Development, etc.), and to a smaller extent by private firms and organizations, non-governmental organizations, etc.

ARD in the country if funded by the state budget (e.g. National Science Fund, National Innovation Fund, state subsidies for Bulgarian Academy of Sciences and Agricultural Academy, etc.), business organizations (own andlanded investments for internal R&D, purchase of intellectual property, commissioning research, sponsorship, etc.), non-governmental organizations, foreign states, international organizations (e.g. EU HORIZON 2020 Program, FAO projects, etc.), private individuals, etc.

"Expenditures for research and development activity" include the current costs and the costs for acquiring long-term material assets, for research and development (R&D) within a statistical unit, independent from the source of funding (NSI). Level of dynamics of that indicator gives insight for the state, financial and material conditions and armament as well as for the evolution of the system for generation, sharing and dissemination of knowledge and innovation in agrarian sphere.

In the past years the expenditures for R&D activity in "Agricultural Sciences" have diminished considerably both absolutely as well as a relative share in the total expendituresfor R&D activity in the country (Figure 1). While the overall amount of the expenditures for R&D activity has increased almost three times after 2007, the

expenditures for R&D activity in "AgriculturalSciences" have diminished with 45%until 2014, and demonstrate a growth afterwards reaching a three-quarters of the initial level in 2017.

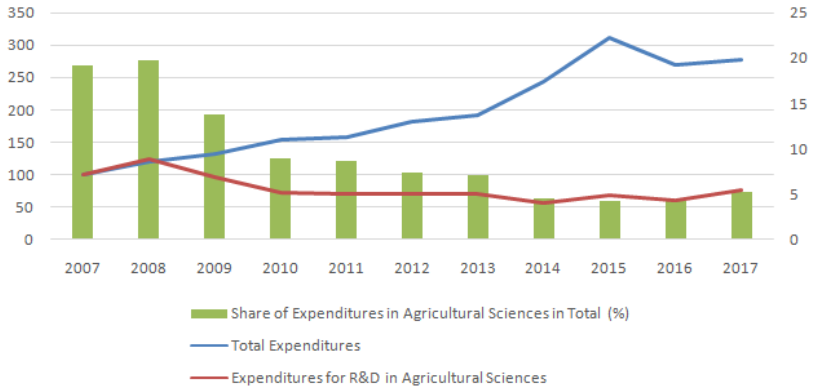

Figure 1. *Evolution of Expenditures for R&D Activity Total for Bulgaria and for Agricultural Sciences (2007=100)*
Source: National Statistical Institute, 2019

Simultaneously, the share of the expenditures for R&D activity in "Agricultural Sciences" have experienced a significant drop in the total expenditures for R&D activity of the country – from around a fifth in 2008 r., to a little more than 4% during 2005-2016, and just above 5% in the end of the period. These data indicate a diminishing importance of the agrarian knowledge and innovation sector in the overall system of knowledge and innovation of the country.

The indicator "Personnel employed in R&D activity" measures the human resources directly involved in R&D activity, who are responsible for generation, application and dissemination of the new knowledge (NSI). It comprises persons, directly carrying R&D activity and persons, directly supporting R&D activity (managers, administrators, bureaucracy, etc.). The level and dynamics of that indicator

shows the staff endowment of the system of R&D activity in the sector.

Since 2007personnel employed in R&D activity in the area of "Agricultural Sciences"initially augment (up to 12% in 2010), and gradually decreases afterwardsto 78% of the initial level in 2017 (Figure 2).That indicates deteriorating of the staff component of R&D activity in agrarian sphere in recent years.

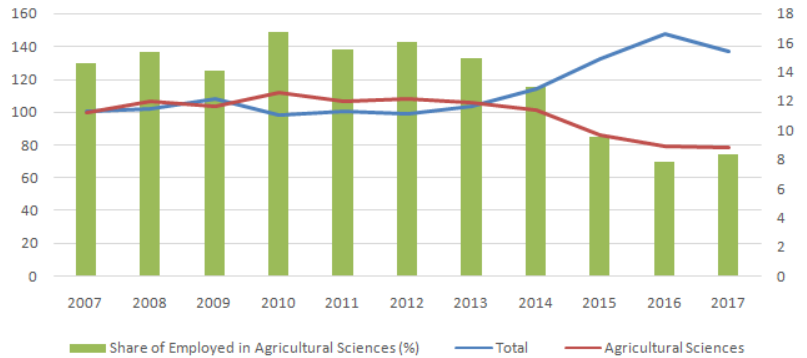

Figure 2. *Evolution of Employed in R&D activity Total for Bulgaria and in Agricultural Sciences, in Full-time Equivalent (2007=100)*
Source: National Statistical Institute, 2019

Simultaneously, there has been a change in the share of the involved with agricultural sciences in the total number of employed in R&D activity. Until 2012 their portion augments from 14,6% to 16%, and after that decline twice in the last two years.

Along with the worsening of the personnel armament of R&D activity in agricultural sciences, there is also a decline in the material and financial endowment of the employed in R&D activity in agricultural sciences. After accession of the country to EU the expenditures for R&D activity per one employed in agricultural sciences fall with more than 45% by 2014 (Figure 3). Since then their amount gradually augments reaching 96% of the level at the beginning of the period.

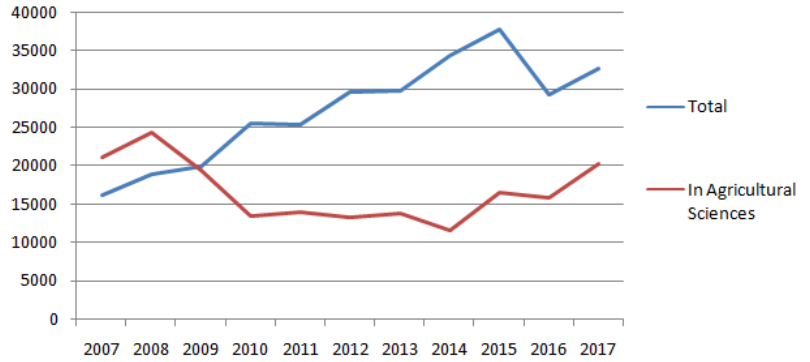

Figure 3. *Amount of Expenditures per One Employed in R&D Activity Average for Bulgaria and in Agricultural Sciences (BGL)*[3]
Source: National Statistical Institute, 2019

During the same period there is a positive tendency for a rise of the average expenditures for R&D activity per one employedin R&D activity in the country. What is more, while in first two years of the analyzed period the expenditures for R&D activity per one employed in Agricultural R&D activity considerably overpass the average in the country (with around 30%), in 2017 r. they account for merely 63,3% of the average level.

These trends in the evolution of agrarian R&D activity in Bulgaria are similar to other EU member states like Spain, Croatia, Slovakia and Lithuania, where it has been registered diminution of expenditures for R&D activity in agriculture in the last years (Figure 4). At the same time in certain EU member states like Estonia, Hungary, Slovenia etc. there has been a significant growth in the overall expenditures for R&D activity in the sector.

[3] 1 Bulgarian Lev (BGL) equal 0,511292 Euro (a fixed rate applies during the period).

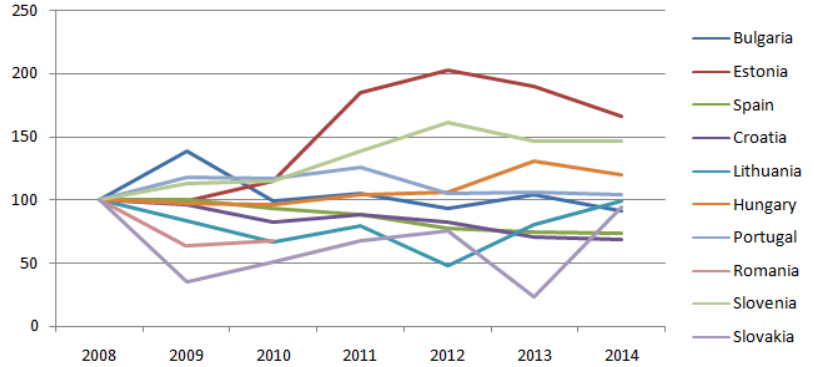

Figure 4. *Evolution of Intramural R&D Expenditures in Sector "Agriculture" in EU Member States (2008=100)*
Source: Eurostat, 2019

In many EU countries there is a tendency for reduction of the relative share of expenditures for agrarian R&D activity in the total for the country. Nevertheless, Bulgaria is among EU countries (along with Croatia, Romania, Hungary, etc.), in which the portion of expenditures for agricultural R&D activity in the overall of the country continues to be the highest (Figure 5). On the other hand, in Slovenia the share of that type of expenditures for R&D activity is insignificant.

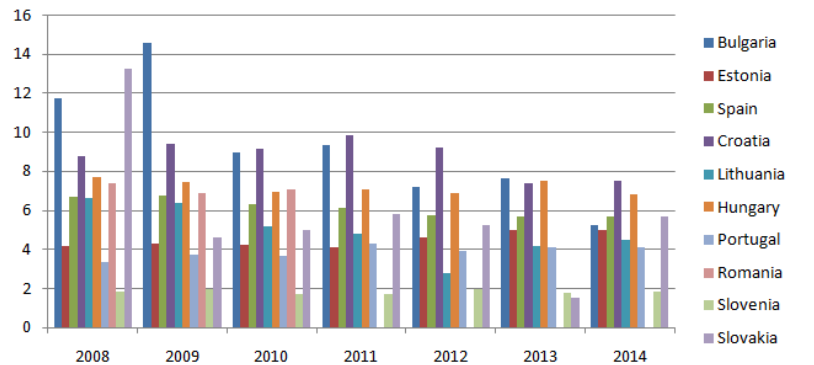

Figure 5. *Share of Intramural R&D Expenditures in Sector "Agriculture" in Total in EU Member States (%)*
Source: Eurostat, 2019

A common tendency in many EU countries is a diminution of the personnel and researchers in agrarian R&D activity (Figure 6).The exception are Netherlands, Portugal and Slovakia, where there is a considerable augmentation of cadre endowment of agricultural R&D activity.

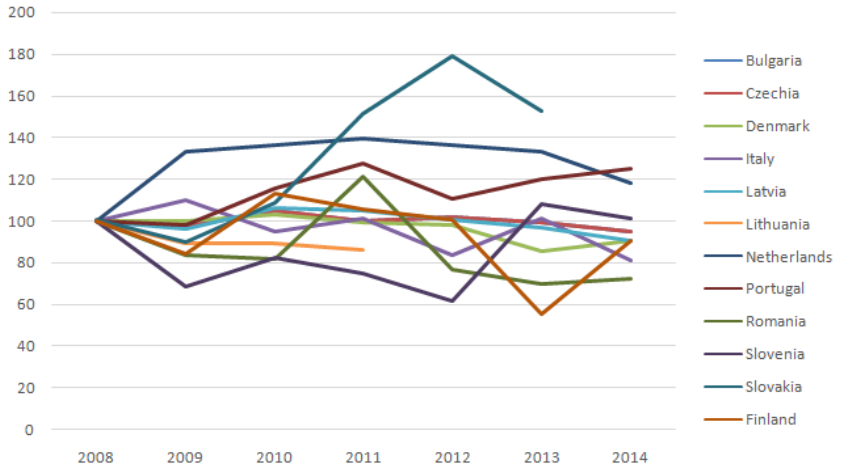

Figure 6. *Evolution of R&D Personnel and Researchers (Full-time Equivalent) in "Agricultural Sciences" in EU Member States (2008=100)*
Source: Eurostat, 2019

In many EU countries there is also a reduction, to a greater or lesser extent, of the share of personnel and researchers in agricultural R&D activity in the total of the country (Figure 7).

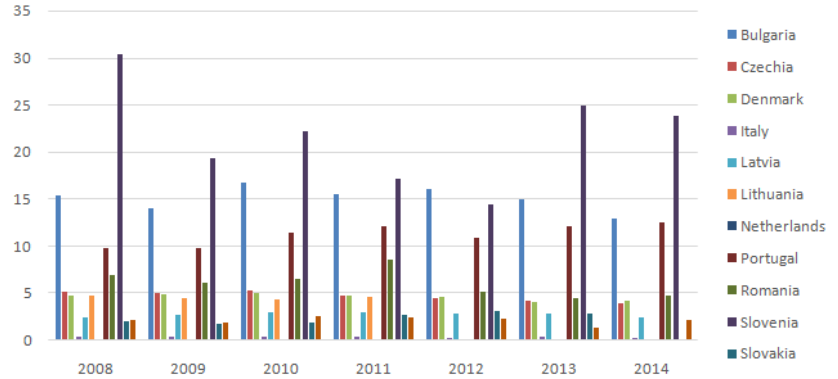

Figure 7. *Share of R&D Personnel and Researchers in "Agricultural Sciences" in Total for the Country in EU Member States (%)*
Source: Eurostat, 2019

However, in Latvia, Portugal and Slovakia there is a reverse trend of enlargement of the later proportion. Slovenia, Bulgaria and Portugal are countries with the greatest relative share of employed in agricultural sciences in the overall employed in R&D activity.

In most of EU member states there is a similar trend like in Bulgaria for a greater or less significant reduction of financial endowment of employed in agrarian R&D activity (Figure 8). Despite that however, the expenditures for R&D activity for one employed in R&D activity in sector Agricultural Sciences in Bulgaria are among the lowest in EU, similar to Slovenia.Regardless of the sensitive decline in the expenditures for one employed in agrarian R&D activity in Slovakia during the period, their amount is 2,7 folds higher than the figure in Bulgaria (2013).

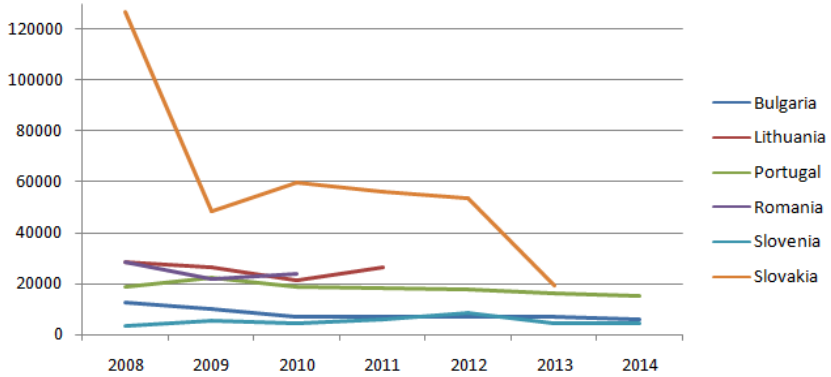

Figure 8. *Intramural R&D Expenditures in Sector "Agriculture" per Full-time Equivalent in Agricultural sciencesin EU Member States (Euro)*

Source: Eurostat, 2019

Science endowment of agriculture

An important indicator for sciencearmament of agricultural production is the share of expenditures for agrarian R&D activity in the Gross Value Added of the sector. Since the accession of the country to EU there is a considerable diminution of the expenditures in R&D activity in sector Agricultural Sciencesin the Gross Value Added of the sector "Agriculture, Forestry and Fishery" (Figure 9). In 2014that indicator is 2,3 folds smaller than the 2007 level. In the last three years there is improvement in the level of "science armament of the sector, but levels are far below the levels for the period before 2012.

The opposite is the tendency in dynamics of the indicator share of total expenditures for R&D activity in the Gross Value Added of the country. There is a positive increase of the scientific endowment as in 2015 this share doubled in comparison with the 2007level.While in the beginning of the period the scientific endowment of the entire economy was 3,5 times lower that in the agrarian sector, it already overpasses the later during 2014-2016. As a result of the

evolution of the expenditures for R&D activity and the Gross Value Added in 2017agriculture demonstrates again a little higher level for this indicators - 0,96% (against 0,87% before).

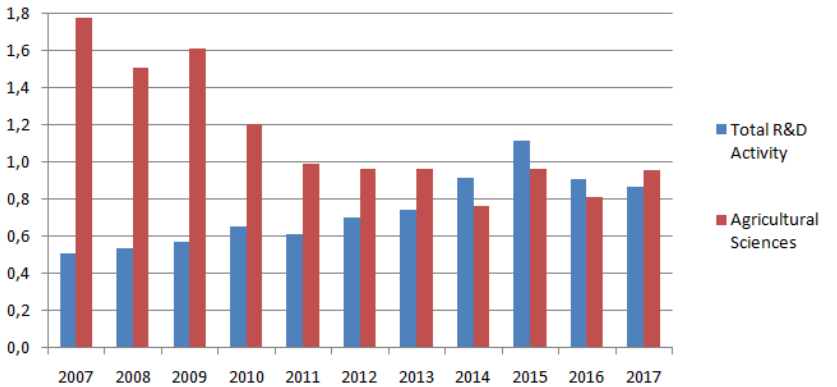

Figure 9. *Share of Total and Agricultural Sciences Expenditures for R&D Activity in the Gross Value Added of Bulgaria and "Agriculture, Forestry and Fishery" Sector(%)*
Source: National Statistical Institute, 2019

It is obvious, that with such pace of progression of investments in R&D activity hardly can be achieved both the EU goals for the amount of investments in R&D activity at 3% of the Gross Value Added in 2020 as well as the national objective of 1,5%.

Science endowment of the Bulgarian agriculture, measured through expenditures forR&D activity in Gross Value Added, is among the lowest in EU along with Romania (Figure 10). In many member states (Estonia, Spain, Lithuania, Hungary, Portugal) the share of expenditures for agricultural R&D activity in the Gross Value Added of the sector falls during the period 2009-2014 (for which there are comparative data), but exceeds considerably that of Bulgaria during entire period. In another group of countries like Croatia and Slovenia the level of this indicators are stable and higher than in Bulgaria throughout the period. On the

other hand, there is a significant growth of the initial level up to amounts exceeding that of Bulgaria, but inferior in comparison to other member states.

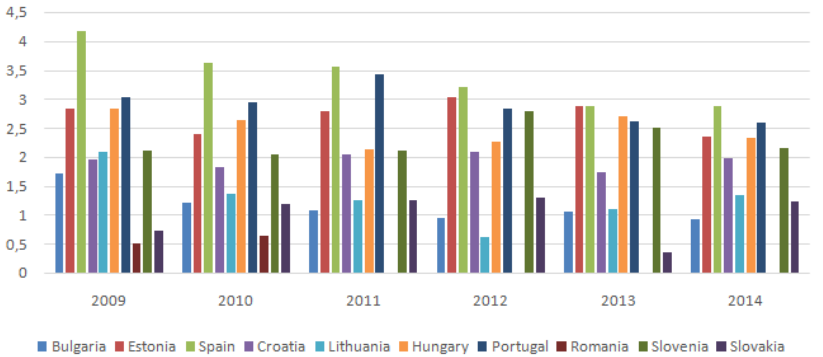

Figure 10. *Share of Intramural R&D Expenditures in Sector "Agriculture" in the Gross Value Added and Income in the "Agriculture, forestry and fishing" Sectorin EU Member States (%)*
Sector: Eurostat, 2019

Another important indicator for science endowment of agriculture is the share of employed in agrarian R&D activity in the totally engaged in agricultural activity. In Bulgaria the share of employed in R&D activity in the "collective workforce"of the sector progressively grows during the period 2009-2015. and fluctuates insignificantly afterwards. The endowment of the sector with workers in R&D activity grows due to the greater reduction of number of employed in agriculture and working time in comparison to diminution of the personnel and researchers in agrarian R&D activity (Figure 11).

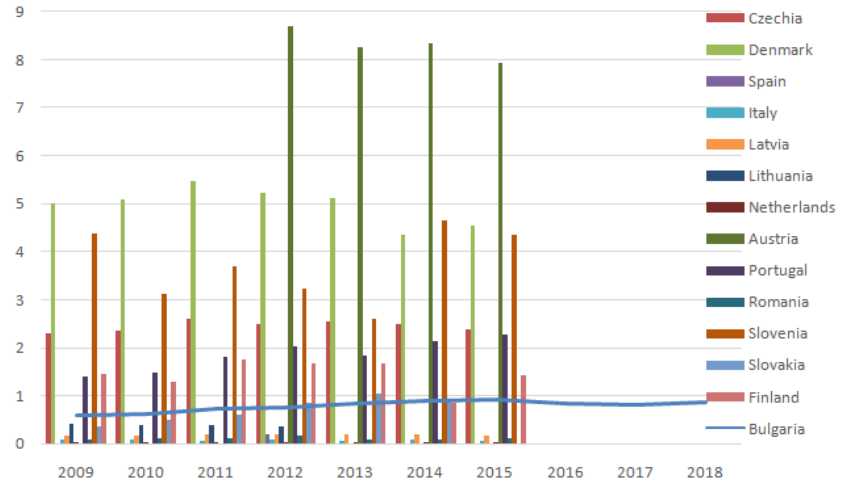

Figure 11. *Share of Employed in R&D Activity in Sector Agricultural Sciences (Full-time Equalent) in Total Workforce of Agriculture (Annual Work Units) in EU Member States (%)*
Source: National Statistical Institute, Eurostat, 2019

In most EU member states during the period 2009-2016 a stable level of science endowment is observed measured by that indicator. In some countries, like Italy, Spain, Latvia, Netherlands and Romania, the proportion of employed in agrarian R&D activity in relations to the overall involved in the sector, is much lower than in Bulgaria. In Slovakia, the level of this indicator is similar to Bulgaria during the good part of the analyzed period.

However, most EU member states significantly surpass Bulgaria in relation to the number of employed in agrarian R&D activity "serving" the employed in agriculture. With the highest endowment of workers in agrarian R&D activity is Austrian agriculture, which is 8,7 folds higher than in Bulgarian in 2016. During the analyzed period in Austria for every 100 employed in farming there are around 8 researchers and persons inR&D activity in AgriculturalSciences, which also explains the big

achievements of that country in generation, sharing and dissemination of knowledge and innovations.

Evolution of major sectors of agricultural R&D activity

Expenditures and personnel potential (capability) of R&D activity are divided in four institutional sectors:

- Business Enterprise Sector, including all firms, organizations and institutions, having a main activity of production of market goods and services (without including those, which are included in sector "Higher Education ");
- Governmental Sector, including state organizations and institutions, which do not sell but provide services for satisfying individual and collective needs of society and funded mainly by the budget (without including those, which are included in sector "Higher Education ");
- Sector Higher Education, including universities, colleagues, high schools, research sectors belonging to high schools and university hospitals;
- Sector of Private Non-for-profit Organizations, including foundations, associations, partnerships etc. providing non-market services.

The level, relative share and dynamics of relevant indicators for these sectors of R&D give insight on the state, development and importance of major sectors for carrying out agrarian R&D activity in the country.

The most important sector of agricultural R&D activity in Bulgaria is the Governmental sector, in which the greatest part of the total expenditures of R&D activity in the sector are invested (Figure 12). With an exception of 2008during entire period after EU accession of the country, in the later sector are allocated more than 80% of overall expenditures for agrarian R&D activity. That sector comprises mostly research

and development organizations, funding their activities from the state budget by priorities determined by the state.

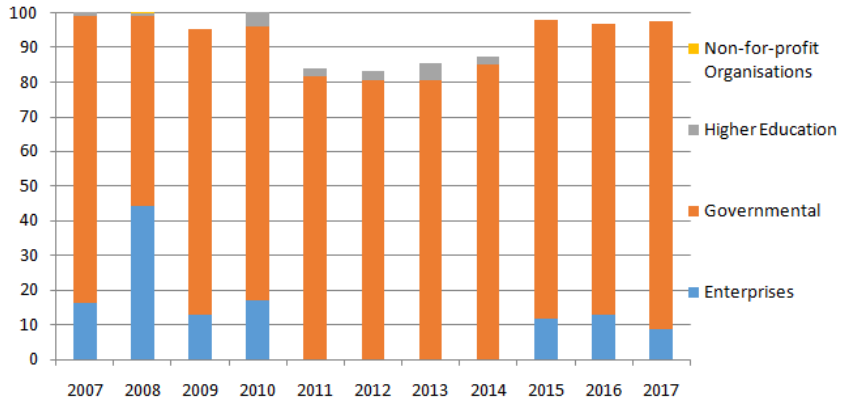

Figure 12. *Share of Expenditures for Agricultural R&D Activity in Major Sectors of R&D Activity in Bulgaria (%)*
Source: National Statistical Institute, 2019

The second most important sector is that of Private Enterprises, which comprises mainly private firms and organizations managing their investments and activity for benefit of owners and according to the rules of market competition. The share of this sector in the total expenditures for agrarian R&D activity considerably varies during the period, being higher during first four years (13-44%), after that there are no data, and in the last three years lower (9-13%).

The third by volume of expenditures for agricultural R&D activity is the sector Higher Education, in which are allocated quite a different portion of the overall expenditures, varying from 0,8% up to approximately5% in individual years, for which data are available.

In the sector of Non-for-profit Organizations are reported expenditures for agricultural R&D activity only for 2008 г. and they account for a tiny portion (0,01%) of the total expenditures in the country.

Distribution of costs and organization of R&D activity in the major sectors of agrarian R&D in Bulgaria differ substantially from other EU member states (Figure 13).In most countries the governmental sector for agrarian R&D activity dominates, but in Bulgaria its share surpasses two and more folds the portion in other member states, for which data are available. In Slovenia expenditures for agrarian R&D activity in the sector Higher Education are the greatest (43% during the period 2008-2012), while in the rest of the countries considerable (a third in Romania, 28% in Spain, and 27% in Hungary).

Unlike Bulgaria in other member states a strong private (business) sector of agrarian R&D activity is also developing, in which are invested a significant part of the total expenditures – a little more than one third in Hungary, almost 29% in Romania, approximately27% in Spain, and 24% in Slovenia.All these indicates unbalanced development of main sector of agrarian R&D activity in Bulgaria in a direction different from the common trends in EU and other developed countries.

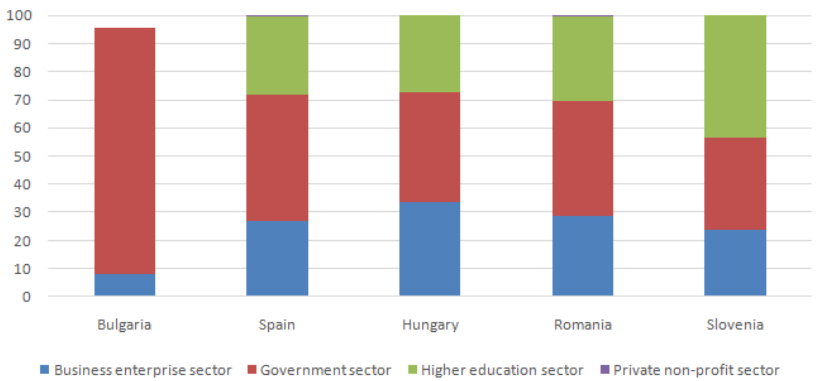

Figure 13. *Share of Agricultural R&D Expenditures in Major Sectors of EU Member States for 2008-2012*
Source: Chartier et al., 2015.

Similar to Bulgaria in the rest of analyzed countries the share of the Private Non-profit sector in the overall amount of agrarian R&D activity is negligible.

The level of expenditures in major sectors of agrarian R&D activity in Bulgaria is with different dynamics since 2007 (Figure 14). While in the sector Higher Education there is a growth of expenditures foragrarian R&D activity, the Government and the Private sectors experience decline. Moreover, the diminution of the expenditures in the Private sector is much bigger than in the Government sector. Furthermore, since 2010now dynamics of the expenditures for governmental R&D activity coincides with the dynamics of the total expenditures for agrarian R&D activity in the country, which confirms the leading role of that sector for R&D in agriculture.

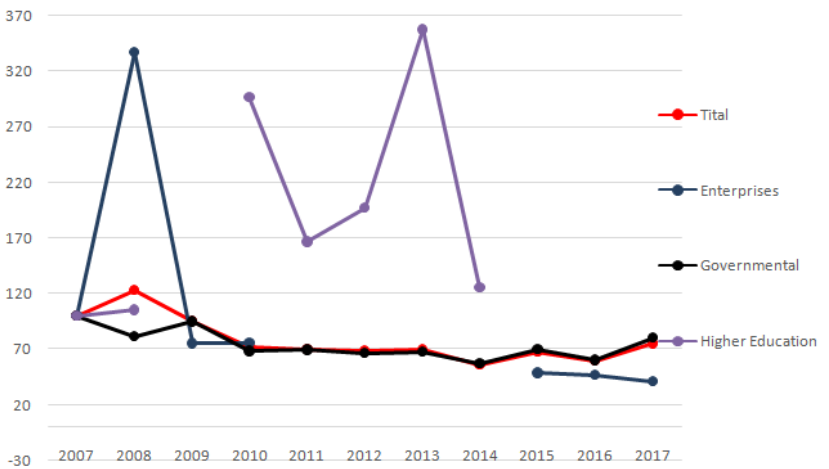

Figure 14. *Evolution of Expenditures for R&D Activity in Agricultural Sciences in Different Sectors of R&D in Bulgaria (2007=100)*
Source: National Statistical Institute, 2019

There are no statistical data doe distribution of the number of workforce in the public (state and university) sector of agrarian R&D activity, but merely in the sector of

Enterprises. In the private sector are employed a small portion of the totally involved in agrarian R&D activity in Bulgaria (Figure 15). The amountof that personnel is little, while their number and share in the overall persons and researchers, engaged in agrarian R&D activity vary considerably in individual years (from 28 to 66persons, and between 1,3% and2,5%).

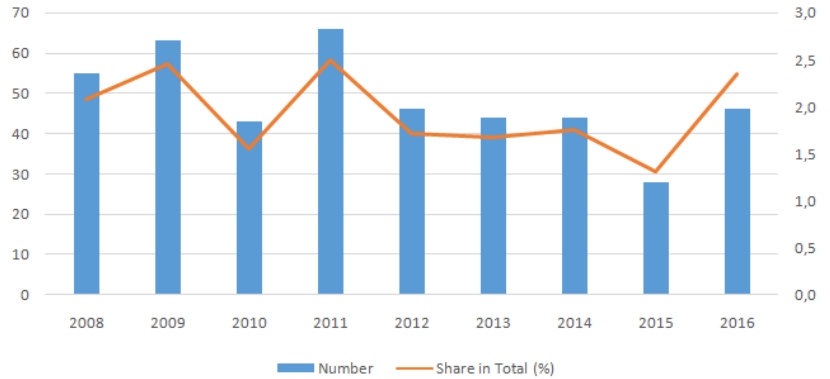

Figure 15. *Number of Employed in Agricultural R&D Activity in Sector Enterprises and Share in the Total Employed in R&D Activity in Agricultural Sciences in Bulgaria*
Source: National Statistical Institute, 2019

At the same time, the endowment with financial and material resources of employed in agrarian R&D activity in the private sector (Enterprises) is multiple times higher than in the public sector (Figure 16). Expenditures for one employed in agrarian R&D activity in the private sector vary significantly in individual year as their level surpasses the average for the country from 5 (2016) to 21 folds (2008). All these expresses the significant lag in development of the governmental and university sectors in financing, payment of labor and modernization of R&D activity in Bulgarian agriculture in comparison with the business sector.

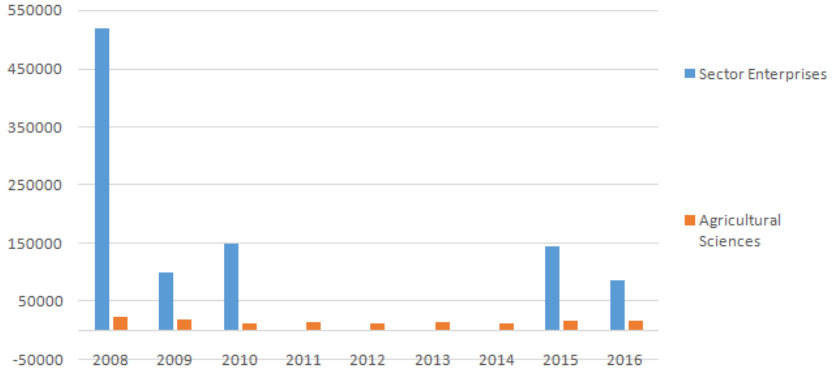

Figure 16. *Expenditures for R&D Activity in Agricultural Sciences per one Employed in Sector Enterprises and Avarage for All Sectors of R&D in Bulgaria (BGL)*
Source: National Statistical Institute, 2019

Funding of agrarian R&D activity

R&D activity in agrarian sphere in Bulgaria is predominantly funded by the state budget. Approximate idea about the importance of that type of financing is given by ration of the amount of budget appropriations for R&D activity for "Development of Agriculture, Forestry and Fishery" to the expenditures for R&D activity in "Agricultural Sciences", averaging for the period of 2008-2017г. at 91,8 (NSI).

The pace of evolution of amount of budget appropriations for agrarian R&D activity is similar to that of the total expenditures for agrarian R&D activity, but the decline of the 2008 level is comparatively smaller (with exception for 2010) (Figure 17).That demonstrate that the importance of the budget financing of agrarian R&D activity relatively increases during the period.

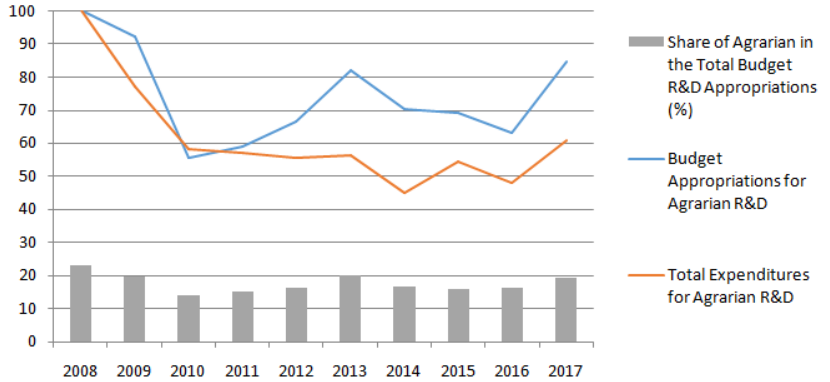

Figure 17. *Evolution of Budget Appropriations for R&D Activity for "Development of Agriculture, Forestry and Fishery ", Share in the Total Budget Appropriations for R&D Activity, and Evolution of Total Expenditures for R&D Activity in Agricultural Sciences in Bulgaria (2008=100)*
Source: National Statistical Institute, 2019

At the same time however, there is a fall in the share of budget appropriations for R&D activity for "Development of Agriculture, Forestry and Fishery"sectorin the total budget appropriations for development of R&D in the country. What is more, the share of agrarian funding of R&D activity from the national budget is quite fluctuating as initiallydramatically falls (from 23% in 2008 to 13,9% in 2013), and after that increases a little bit (up to 19,2% in 2017). Thesefigures give insight for the diminishing social significance ofagrarian R&D activity and their unsustainable funding by the national budget.

The budget financing of agrarian R&D activity in Bulgaria is mainly carried out through direct "institutional" subsidizing of Agricultural Academy and Bulgaria Academy of Sciences[4], project funding through diverse national, bilateral etc. science programs of the

[4] Bulgarian universities get some very small budget subsidies for R&D activity.

National Science Fund of the Ministry of Education and Science, and projects for innovation in small and middle size enterprises of the National Innovation Fund of the Ministry Of Economy, etc. For instance, 8% of the budget of the National Science Fund in 2017 is for "Agricultural Sciences"– for 11 projects 45% of which for the institutes of the Agricultural Academy, 36% for the institutes of the Bulgaria Academy of Sciences, and the rest for 2 universities (MES).Implemented programs of the funding agencies aim at achievement of the strategic priorities of the country (competitiveness, sustainable development, etc.), and they are in line with EU priorities.

Since 2009 now in EU as a whole there are slight fluctuations in both directions in the level of budget appropriations for agrarian R&D activity (Figure 18). However, in individual member states there is unlike changes in the financing from the national budget of R&D activity in agriculture. In Germany and France budget appropriations for agrarian R&D activity experience constant growth. In Check Republic budget appropriations falls a little bit, and recover initial level afterwards. In Austria and Romania there is initial augmentation of the budget support and subsequent drop below initial level.

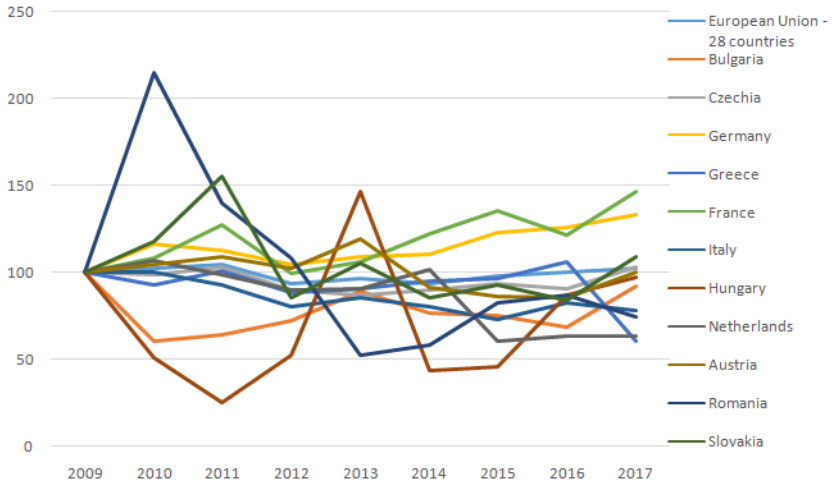

Figure 18. *Evolution of Government Budget Appropriations or Outlays on R&D in Agriculture in EU Member States (2009=100)*
Source: Eurostat

In most EU member states there is a tendency for permanent reduction of the importance of the state budget in the sustentation of R&D activity of agriculture. What is more, for certain countries like Greece, Netherlands and Italy the decline of the budget funding of agrarian R&D activity in recent years is significantly greater than in Bulgaria.

Private business investments in R&D activity are "market oriented" and aim at satisfying some practical needs of innovation and realization of economic and other benefits (profit, improving market positions and relations with counterparts, modernization and atomatizationof processes, introduction of know-how, new products and technologies, etc.).They are also a means for direct connection of interested parties and effective sharing of knowledge and innovation for satisfaction of specific needs in agrarian sphere.

The level of business expenditures (of Enterprises) for R&D activity in "Agriculture, Forestry and Fishery" sector in Bulgaria varies substantially in different years (Figure 19).

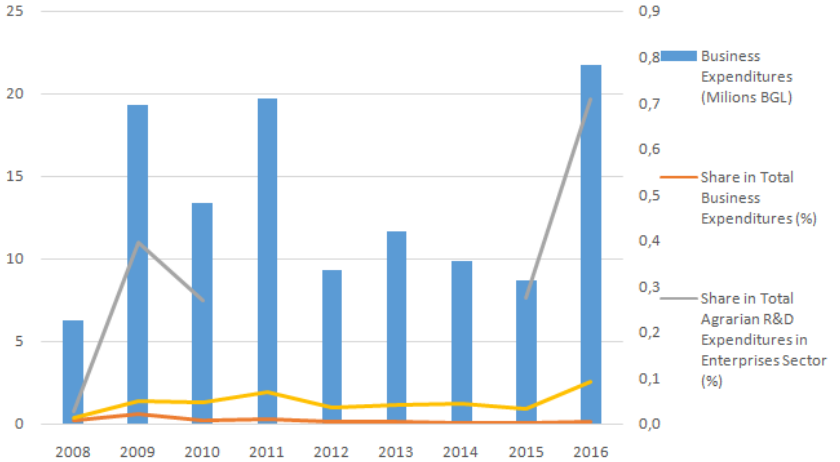

Figure 19. *Amount of Expenditures for R&D Activity in Sector Enterprises in "Agriculture, Forestry and Fishery" and Share in the Total Expenditures for R&D Activity in "Agricultural Sciences" in Bulgaria*
Source: National Statistical Institute, 2019

The share of the private sector for financing agrarian R&D activity is insignificant, as they account for a tiny portion (0,05-0,31%) of the total business investments in R&D activity of the country. The later demonstrates that incentives for business investments in R&D activity in agriculture are still small generally as well as in comparison with other sectors of the economy.

Above is also supported by the fact that the expenditures of the enterprises for agrarian R&D still comprise relatively little share of the total expenditures for agrarian R&D activity of the country – from 0,35% to 2,5%. That indicates besides lack of sufficient incentives (profit, other benefits) also low (staff, technical, financial, etc.) capability for private R&D activity at the contemporary stage of development of Bulgarian agriculture.

However, for carried in the sector of Enterprises agrarian R&D activity, in individual years private (business) investments in agrarian R&D activity accounts a good

proportion of the overall expenditures for R&D activity of Enterprises (from 7,5% to almost 20%). The later confirms, that when there are sufficient incentives and benefits the private sector actively involves in funding and execution of R&D activity in the sector.

Bulgaria, along with Lithuania and Slovenia are among the countries of EU with the smallest share of the business expenditures for R&D activity in "Agriculture, Forestry and Fishery" in the total expenditures for R&D activity in the sector "Agriculture" (Figure 20).In certain countries, like Romania and Hungary, private funding of R&D activity represents a considerable portion in the R&D activity of agriculture.

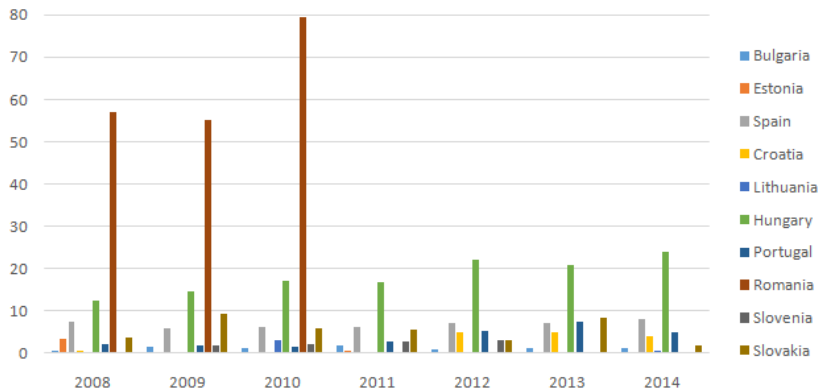

Figure 20. *Share of Business Expenditures on R&D in "Agriculture, forestry and fishing" in Total Intramural R&D Expenditures in Sector "Agriculture" in EU Member States (%)*
Source: Eurostat

In the EU member state there are several trends in the size of business expenditures for R&D activity in agriculture during the period 2008-2016, for which data are available (Figure 21).

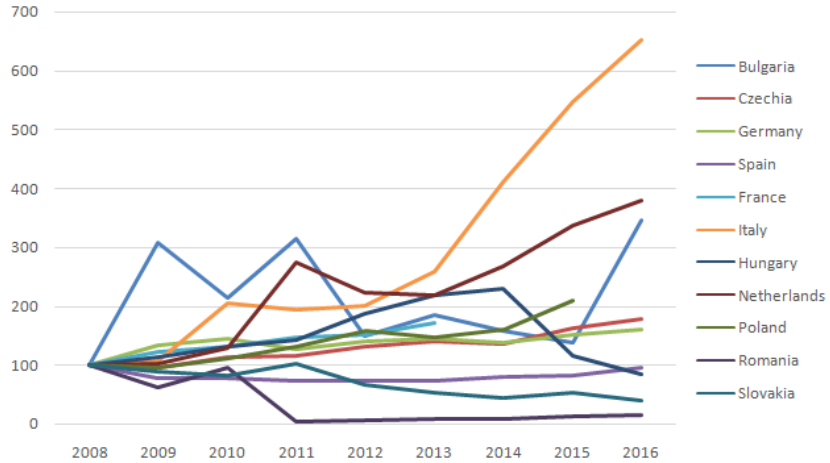

Figure 20. *Evolution of Business Expenditures on R&D in "Agriculture, forestry and fishing" in EU Member States (2008=100)*
Source: Eurostat

In the first groups are countries, in which the business expenditures for R&D activity in agriculture show constant (France, Check Republic and Poland) and significant (Italy and Netherlands) growth.

In other group countries (Romania and Slovakia), the amount of business investments in agrarian R&D activity demonstrate sizable drop.

In a third group of countries the level of private expenditures for R&D are relatively stable during the analyzed period after initial decline (Spain) or upsurge (Germany).

And finally, there are countries like Bulgaria and Hungary where business expenditures in agrarian R&D of enterprises fluctuate significantly up and down in different years.

Conclusions

During the years since the accession of Bulgaria to EU expenditures for R&D in agricultural sciences considerably

decrease both absolutely as well as relatively as a share in the total investments in R&D of the country. That indicates diminishing importance and deteriorating financial and material endowment of agrarian sector of knowledge and innovation. In the past several years the personnel endowment for R&D activity in agrarian sphere also deteriorate due to a great reduction of persons employed in R&D activity in sector Agricultural Sciences as well as their relative share in the overall workforce of R&D activity of the country.

The most important sector of agricultural R&D activity in the country is the governmental one, in which are invested more than 80% of overall expenditures for R&D activity in agriculture. Distribution of the expenditures and organization of R&D activity in the major sectors of agrarian R&D activity in Bulgaria differ greatly from other member state of EU, in most of which the government sector dominates, but with a considerably lower share et the expense of sector Higher Education and strongly developed private (business) sector of agrarian R&D activity. All this demonstrates unbalanced development of main sectors of agrarian R&D activity in Bulgaria in a direction unlike common trends in EU and other developed countries.

R&D activity in agrarian sphere in Bulgaria is predominantly financed by the state budget, as the role of budget funding of agrarian R&D activity relatively increases during the period. That trend is dissimilar to most EU member states where there is a constant diminution of the importance of the national budget appropriations in the overall R&D activity of agriculture.

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Иванов Б., Р. Попов, Х.Башев, Н. Котева, Н. Маламова, М. Чопева, К. Тодорова, И. Начева, Д.Митова (2020): ДОКЛАД АНАЛИЗ НА СЪСТОЯНИЕТО НА СЕЛСКОТО СТОПАНСТВО И ХРАНИТЕЛНОВКУСОВАТА ПРОМИШЛЕНОСТ SWOT АНАЛИЗ, ИАИ [Retrieved from].

3 Diagnosis of the process of agrarian and rural digitalization in Bulgaria

Introduction

Simulating and sharing knowledge, innovation, digitalization and promoting their greater use" is set again as a strategic objective in the new programming period 2021-2027 of implementation of the EU (European Union) CAP (Common Agricultural Policy) (European Commission, 2018). Despite their importance, with very few exceptions (Башев, 2020; Башев и Михайлова, 2019; Николов и др., 2018; МЗХГ, 2019; Bachev, 2019, 2020), in-depth analyzes of the digitalization of the agricultural sector and in rural areas are lacking. The reason for this is the lack of enough official statistics, etc. information and sufficient public interest in the development of this important system.

The study attempts to analyze the state, development and efficiency of digitalization in in Bulgarian agricultural and rural sector since the EU accession of the country in 2007. The aim is to specify key trends, compare with other EU

countries, identify major issues, and assist public support policies in the next programming period.[1] Analysis is based on available statistical, reporting and other official information as well as a specially organized experts evaluation (2019), with 32 leading experts from the major research institutes, universities, Agricultural Advisory Service, and professional organizations of agricultural producers.

Diagnosis of digitalization in the Bulgarian agrarian sphere

The use of the Internet and information technology and applications is rapidly entering Bulgarian agriculture and rural areas. However, the country lacks statistics on the degree of use of computers and digital technologies in the agricultural sector, which greatly complicates the study and management of this process.

Over the last 10 years, there has been a significant improvement in the access of Bulgarian households to the Internet as a whole and in the regions with varying degrees of population density (Figure 1). It can be assumed that the general trends in the country apply to both rural households and farmers' households, which means that the use of the Internet is progressively increasing in the agricultural sector.

[1] In fact, that analisis is being used for identifying public intervention needs and measures in the 2021-2027 Program for Agrarian and Rural Development of Bulgaria (Иванов, Башев и др., 2020).

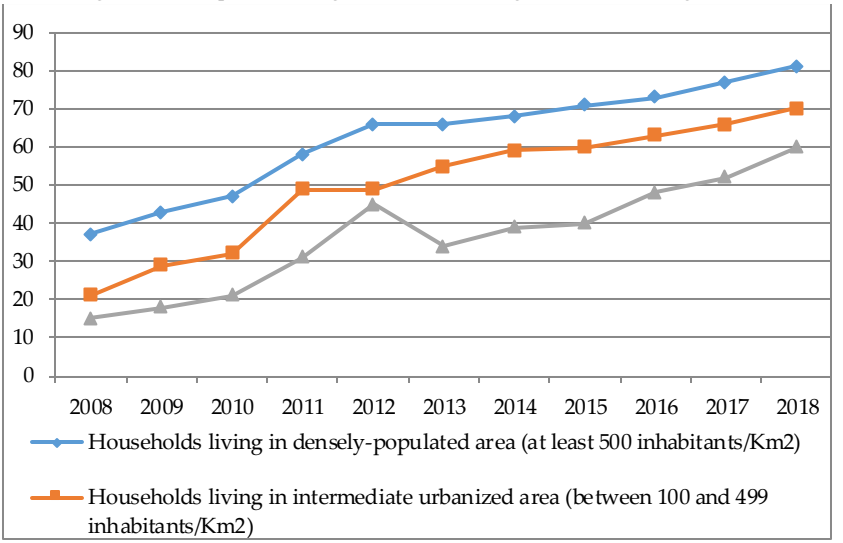

Figure 1. *Internet Access of Households in Different Regions of Bulgaria*
Source: Eurostat

However, despite the significant progress, there are still large differences in household Internet access in densely populated areas (at least 500 inhabitants/km2) and medium-urbanized populations (between 100 and 499 inhabitants/km2), and sparsely populated areas (less than 100 inhabitants/m2) regions of the country - 81%, 70% and 60% of them respectively. It can be assumed that farmers living in the areas concerned use approximately the same extent of the Internet.

Bulgaria lags far behind in digitalization as a whole and in rural areas and in comparison with the European average and other EU countries (Figure 2). The country is in the group of lagging countries along with Greece, Lithuania and Latvia, ranking last in internet access in all categories of regions.

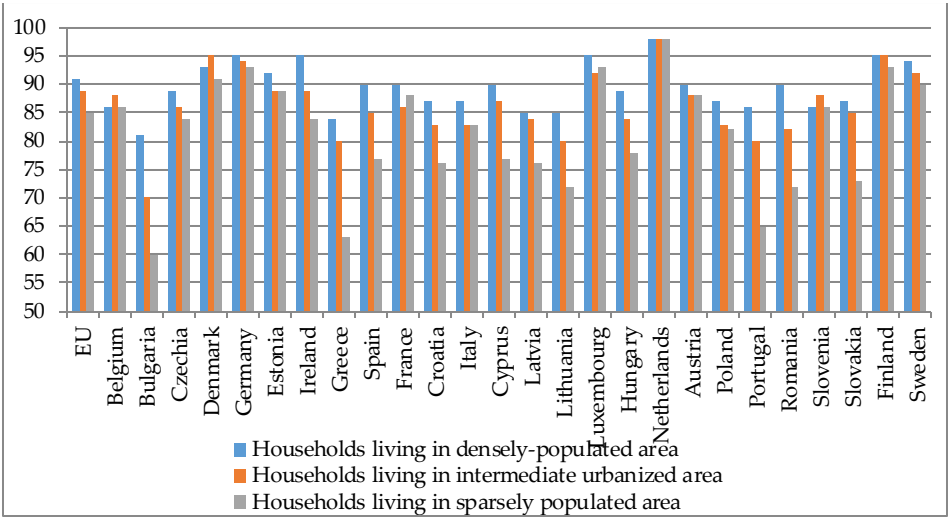

Figure 2. *Households Level of Internet Access in EU member States in 2018*

Source: Eurostat

Nevertheless, 68.5% of people aged 16-74 in the country use a variety of mobile devices to access the internet at home or at work - mobile phone or smartphone, portable computer (laptop, tablet) or other mobile device (gaming media player, e-book reader, smart watch) (Figure 3). In 2018, only 7.8% of the individuals have not used such devices to access the Internet in the last 12 months. This implies that many farmers and members of their households use this type of devices for internet access.

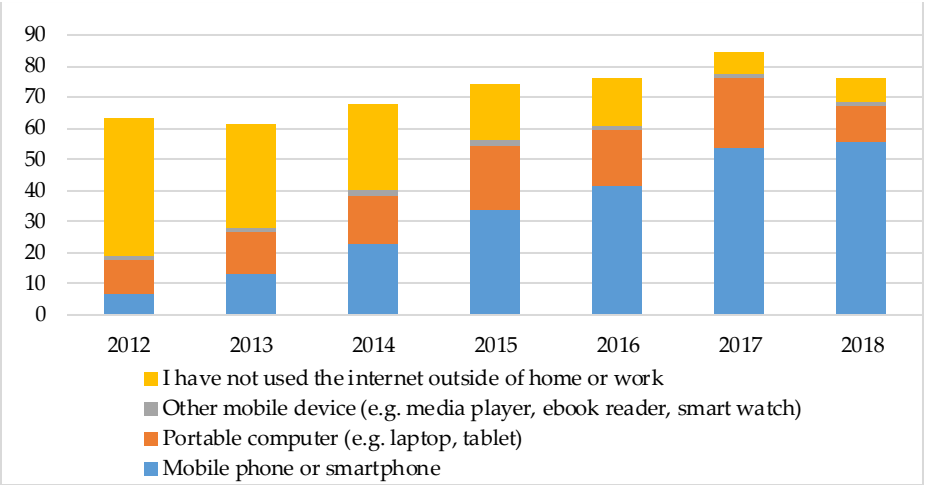

Figure 3. *Usage of Mobile Devises by Persons for Access to Internet (outside of home or office), %*
Source: National Statistical Institute

Over the last ten years, the number of people using the Internet to interact with public institutions or to order/purchase goods and services has increased significantly (Figure 4). In 2018, just over a fifth of the population have used the Internet to engage with public and private organizations in the last twelve months. Compared to other EU countries, however, the development and use of e-government and e-commerce is much smaller, with Bulgaria last (along with Romania) in this regard (Figure 5, Figure 6).

It can be assumed that the implementation of digital relations with public institutions and commercial organizations in rural areas and among farmers has a similar trend, but is less widespread.

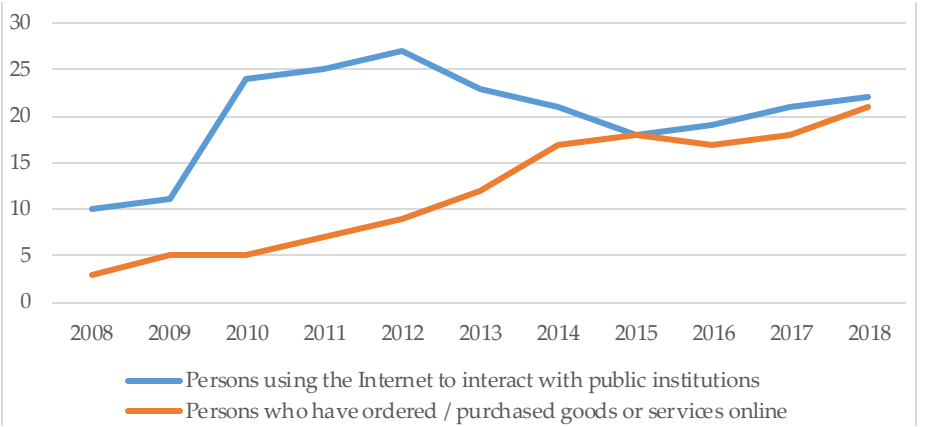

Figure 4. *Individuals Using Internet for Relations with Public Authorities and Order/purchase of Good or Services in Last 12 months*
Source: Eurostat

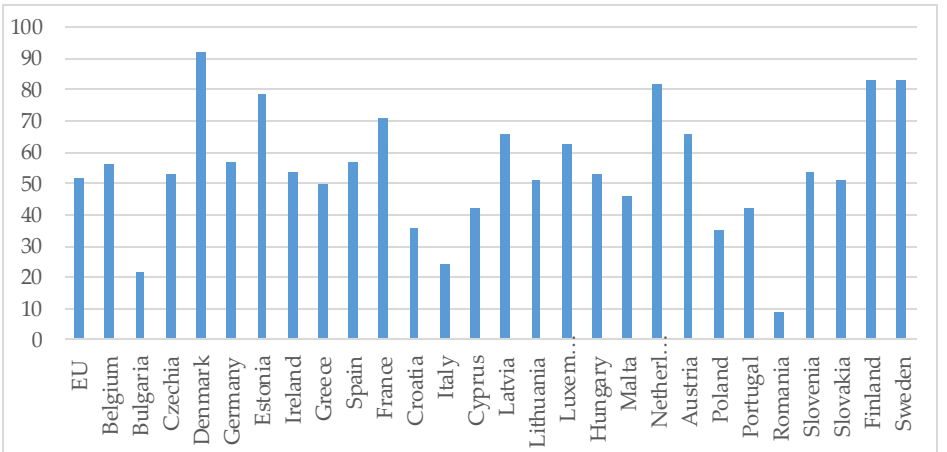

Figure 5. *Individuals using the internet for interaction with public authorities in EU countries (%)*
Source: Eurostat

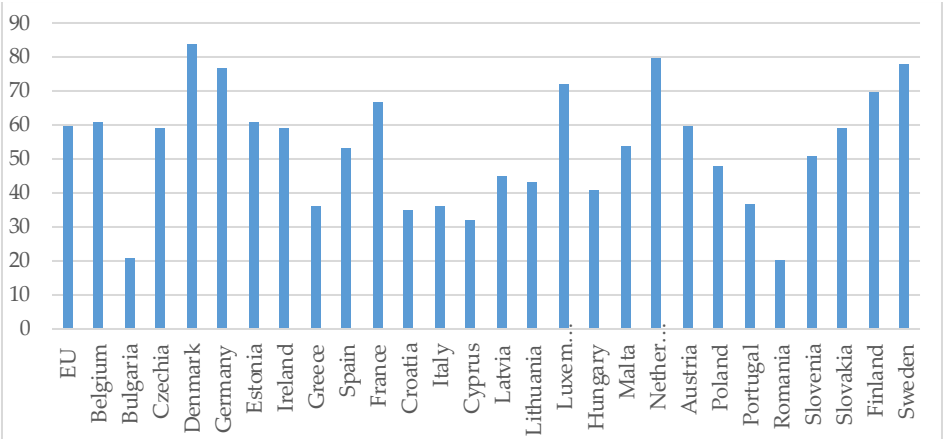

Figure 6. *Individuals using the internet for ordering goods or services in EU countries (%)*
Source: Eurostat

The National Rural Development Program 2014-2020 states that access to a standard broadband network is provided for almost all households in rural areas (99%), but in sparsely populated rural areas only 60% of households have access to a fixed broadband network (at 90% national average) (МЗХГ, 2015) Moreover, only 10% of rural households have access to next-generation networks, with broadband penetration in rural areas increasing but lagging far behind the pace in the country and other countries, with only 37 % of households in predominately rural regions having subscription to internet.

The use of the Internet by businesses and households for e-commerce, Internet banking, information and training is far from potential possibilities. By the end of June 2015, Bulgaria has coverage of a new generation of broadband access infrastructure (> 30Mbps) for 72% of the households but reaching only 2.7% in rural areas, well below the EU average.

The in-depth analysis also shows that Bulgaria lags far behind the other EU member states in terms of digital

penetration into the economy and society. In recent years (2017 and 2018), the country ranks 26th in the EU in the Integrated Index of Digitalization of Economy and Society - The Digital Economy and Society Index-DESI (DESI, 2019).

In terms of DESI measurement for "Connectivity", Bulgaria ranks 25th in the EU. For some of the indicators, the country approaches the Union average (such as Total coverage of fixed broadband households, and Broadband mobile broadband) and even exceeds it by some areas (e.g. Broadband high speed broadband, and ultra-fast Broadband Internet coverage) (Table 1). However, in terms of 4G coverage and ultrafast broadband Internet access, Bulgaria is still well below EU levels.

Table 1. *Indicators for Internet Connectivity in Bulgaria, 2018*

Indicators	DESI		Ranking
	Bulgaria	EU	in EU
Fixed broadband coverage,% households	95	97	23
Fixed broadband Internet distribution,% households	59	75	26
4G network coverage,% households	72	91	28
Distribution of mobile broadband Internet access, subscriptions per 100 people	87	90	16
Next Generation Access Coverage,% VDSL, FTTP or Docsis 3.0 Households	75	80	23
Broadband Broadband Broadcast,% Subscriptions>= 30 Mbps	39	33	15
Ultra-fast broadband Internet coverage,% FTTP or Docsis 3.0 households	75	58	12
Broadband Broadband Internet Distribution,% Subscriptions>= 100 Mbps	6,5	15,4	23
Fixed Broadband Price Index, score (0 to 100)	80	87	20

Source: DESI, Report for Bulgaria, 2018

As regards to the "Human Capital" in digital technology area, Bulgaria is also making slow progress, with the overall level of skills being among the lowest in the EU (27th) and the level of all indicators below the Union average (Table 2).

Table 2. *Indicators for Human Capital in Digital Technologies in Bulgaria, 2018*

Indicators	DESI		Ranking
	Bulgaria	EU	in EU
Internet users, % of persons	62	81	27
At least basic digital skills, % of persons	29	57	27
ICT specialists, % of employees	2,7	3,7	20
Specialists in the field of science, technology, engineering and mathematics, per 1000 persons (aged 20-29)	13,9	19,1	21

Source: DESI, Report for Bulgaria, 2018

In terms of "Internet Usage", the country is among the last places in the EU (26), with major indicators showing significant differences depending on the activities carried out online. While Bulgarians intensively use the Internet for telephone and video calls and are active on social networks, they are far behind European levels in terms of e-commerce and the use of online banking (Table 3).

Table 3. *Indicators for usage of internet in Bulgaria, 2018*

Indicators	DESI		Ranking
	Bulgaria	EU	in EU
News, % of people who have used the internet in the last 3 months	74	72	20
Music, videos and games, % of people who have used the internet in the last 3 months	64	78	28
Video on demand, % of people who have used the internet in the last 3 months	8	21	23
Video calls, % of people who have used the internet in the last 3 months	85	46	1
Social networks, % of people who have used the internet in the last 3 months	79	65	5
Banking, % of people who have used the internet in the last 3 months	9	68	27
Shopping, % of people who have used the internet in the last 12 months	27	68	27

Source: DESI, Report for Bulgaria, 2018

In terms of "Introduction of Digital Technologies", the country is also one at the last places in the EU (26) and the use of digital technologies in Bulgarian enterprises is generally well below the European levels (Table 4). It can be assumed that in the agricultural and rural enterprises the implementation of these technologies is lagging behind even more than in the cities and high-tech industries.

Table 4. *Indicators for Introduction of Digital Technologies in Bulgaria, 2018*

Indicators	DESI		Ranking in EU
	Bulgaria	EU	
Electronic information sharing,% businesses	23	34	25
Radio frequency identification, % of enterprises	9,2	4,2	1
Social media, % businesses	9	21	28
Electronic invoices ,% businesses	12	na	21
Cloud computing services, % enterprises	5,5	na	27
SMEs that sell online	7,1	17,2	28
E-commerce turnover, % of SME turnover	3,5	10,3	26
Cross-border online sales	3,4	8,4	27

Source: DESI, Report for Bulgaria, 2018

Similar is the situation with regard to the "Digital Public Services", where the country is ranked 23rd in the EU. According to many of the observed general indicators, Bulgaria is well below the Union average, and it can be assumed that the situation in the agricultural and rural areas is similar or even worse (Table 5).

Table 5. *Indicators for Introduction of Digital Technologies in Bulgaria, 2018*

Indicators	DESI		Ranking
	Bulgaria	EU	in EU
EGovernment users, % users who want to submit forms	58	58	15
Form pre-completion, score (0 to 100)	25	53	24
Completeness of online services, score (0 to 100)	72	84	26
Digital public services to business enterprises (0 to 100) - national and cross-border	89	83	11
Open data, % of maximum score	76	73	14
EHealth, % persons	10	18	23

Source: DESI, Report for Bulgaria, 2018

A MAFF survey among farmers in 2019 on digitalization of Bulgarian agriculture found out that for the question "Are you familiar with the nature of digital agriculture" the majority (49%) answered that they are not familiar, 27% are partially familiar, 19% are average familiar, and only 5% are familiar to a great extent (МЗХГ, 2019).

With regard to the question "Do you use modern digital technologies on your farm" 86% of the respondents said that they do not use modern digital technologies and the remaining 14% use digital technologies, mainly GPS navigation systems.

To the question "Do you expect digitalization to affect the number of employees on your farm?" 83% said they expect a change, 13% said they expect the number to decline and only 4% said they expect a staff increase.

To the question "Do you have a department or designated employee who is specifically responsible for digitizing on your farm?" only 8% of the respondents said that they have an employee in charge of digitization and the majority (92%) have no such an employee.

To the question "Do you plan to invest in the next five years for the development of digitalization in your farm?"

4% said they intend to invest more than 10% of their planned investment funds for digitalization, 96% said they intend to spend less than 10% of their planned funds or do not intend to spend any money at all for digitalization.

To the question "Do you intend to link your production with digitalization in the future?" 38% of respondents stated that they intend to digitize their production, 33% intend to digitize only some of the production stages, and the remaining 29% plan to introduce digital technology within the next five years.

To the question "What do you think would be the benefits for your farm with the introduction of digital technologies?" 22% cite efficiency gains, 17% cost reductions, 16% better planning and management, 14% productivity gains, 12% data acquisition and analysis, 9% competitiveness retention, 4% increase in turnover, 2% say more value added and the ability to customize products, 1% point "Time-to-market" acceleration, and 1% see no benefit in digital technology.

To the question "What do you think are the potential barriers and risks to digital adoption?" 24% of respondents indicate employee qualifications, another 24% indicate the amount of investment, 19% identify unclear economic benefits, 15% data security, 7% insufficient maturity of technologies, 5% insufficient standardization and certification, 3% insufficient capacity for recording and storing digital information, 2% lack of clear priorities by the management of the holding, and 1% cannot identify risks and obstacles to the entry of digital technologies.

To the question "In what areas is public administration action required regarding the introduction of digital technologies?" 21% of respondents indicate support for measures for further qualification of employees, another 21% indicate tax incentives for planning of measures and digitization of activity, 18% encouragement of young professionals, 11% introduction of internationally recognized

standardization and certification processes, 11% adapting data protection legislation, 11% securing high-speed and high-speed networks, and 7% promoting development activity.

A representative survey of farms in the mountainous regions of the country in 2017 found that only 5% of producers actually use computer programs in agricultural management (Figure 7). However, more than half of the respondents (54.1%) express in one way or another positive attitudes towards such programs. However, there is still a significant proportion of farmers (38.3%) who lack interest in acquiring knowledge of these programs and their implementation. This requires special measures to inform and advise farmers on the benefits of such programs, as well as training them in their use.

It can be assumed that there are no significant differences in the intentions and degree of use of computer programs in agricultural management in areas other than mountainous.

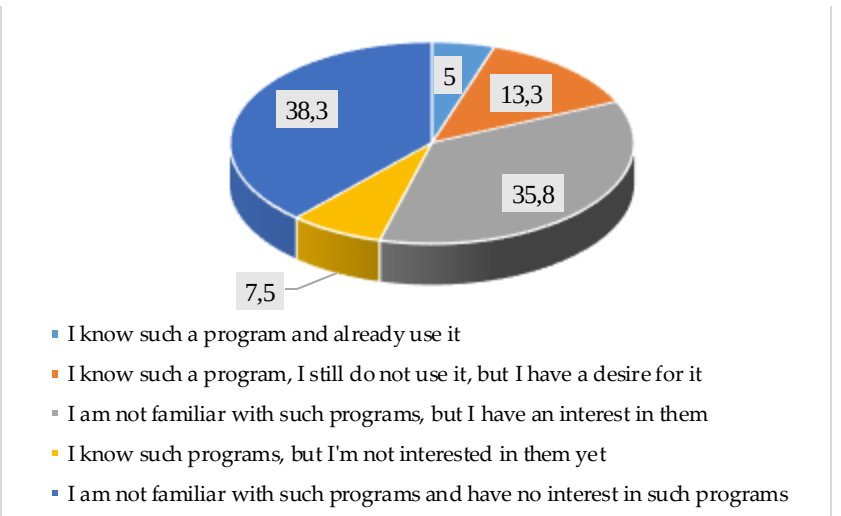

Figure 7. *Farmers Attitude in Mountainous Regions of Bulgaria to Computers Programs in Farm Management (%)*
Source: Николов Д. и др., 2018

In the last years in the EU there have been carried out numerous activities related to the digitization of agriculture and the promotion of innovation, including within the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI).

In 2016, the European Commission launched the Digital Industry Strategy for the European Industry within the Digital Single Market Package, which creates and complements the various national digitization initiatives of the economy. One of the pillars of the initiative is the establishment of a Pan-European Digital Innovation Hubs (DIHs) network. The DIHs are a one-stop shop that helps businesses become more competitive with their business/manufacturing process, products or services through the use of digital technology. The DIHs are based on technological infrastructure (competence centers) and provide access to up-to-date knowledge, expertise and technologies to support consumers through pilot projects, testing and experimentation of digital innovation. DIHs are seen as a tool to support businesses, and in particular for SMEs and the non-technology industry, in their digital transformation The goal is for all businesses in Europe, including agri-food, to have access to DIHs at a "working distance".

Under Horizon 2020 in 2019 AgroHub.BG was established in Bulgaria at the initiative of the Institute for Agro-Strategies and Innovations. The goals of this Digital Innovation Hub are: Digital transformation of Bulgarian agriculture and rural areas using digital technologies like Blockchain, Internet of Things, Artificial Intelligence and others; Increasing the role of research and digital innovation in the agri-food chain; Contributing to the spread of international practice in the field of research and digital innovative technologies in the agro-food chain, and the implementation of this practice in the country; Contributing

to accelerate the implementation of research and digital innovation by practitioners to meet the needs of Bulgarian enterprises; Providing access to up-to-date knowledge, expertise and technology to support Bulgarian enterprises with pilot projects, testing and experimentation of digital innovation; Collaboration with Bulgarian enterprises to assess digital skills needs and to provide access to these skills. AgroHub.BG's main activities include: Project development; Developing knowledge and skills; Access to finance; Maintenance of units such as Incubators and Accelerators; Testing and validation; Technical assistance for enlargement; Provision of technical infrastructure; Contract research; Strategic research and development; Lobbying; Study of ecosystems; Strategic development; Building a community.

Large-scale measures have also been taken in recent years to digitize the agricultural administration in the country. As a result, a number of information systems, databases, software products and registers have been built into the Ministry of Agriculture, Food and Forestry (MAFF) system in several main groups: Registers serving the general administration; Registers serving the specialized administration; Registers within the scope of the GIS system, etc. At the same time, the volume of documents submitted and processed electronically increases. Simultaneously, the MAFF is developing an "Information System with Electronic Registers for the Specialized Administration (EPCA)", which aims at creating a unified information system. In addition to merging electronic registers, this system will also provide consolidated data coming from different internal or external systems/registers for the purposes of specialized administration. The deadline for the creation of the EPCA was until the end of 2019. The Integrated Information System for Spatial and Registry Data for the implementation of MAFF functions is also under development. All this leads

to an increase in the efficiency of the administration and an improvement in the service provided to farmers.

As part of the EU's Sixth Priority for "Promoting Social Inclusion, Poverty Reduction and Economic Development in Rural Areas, with an Emphasis on Improving Information, Communication and Communication (ICT) Access, Use and Quality in Rural Areas", in the RDP 2014-2020 EUR 30 000 000 are planned for under measure 7.3 - Support for broadband infrastructure, including its creation, improvement and expansion, passive broadband infrastructure and measures for access to solutions though broadband infrastructure and e-government. Measure 7.3 implements two objectives – of the RDP and the National eGovernment Development Plan. The sub-measure is also consistent with the National Broadband Development Strategy in Bulgaria and as such, part of its activity supports the goals of the State Agency for Electronic Governance (ДАЕУ), which is also the sole beneficiary. The goal is, by 2020, the entire rural population to be able to access the next generation with a capacity of at least 30 megabits per second. In this regard, one of the goals (concerning the development of e-government) is to establish optical connectivity to all municipal centers.

The main problems associated with sub-measure 7.3 are the lack of guarantee that after the construction of the optical infrastructure in the municipal centers, there will be interest from the operators to develop the so-called "last mile", which is fact is a necessary condition for the population to have access to next-generation broadband and to fulfil the objectives of that sub-measure. Other issues related with the sub-measure are determined by the need to notify state aid, as the infrastructure will generate revenue and possibly unbalance the principles of a level playing field between market participants in broadband services.

In 2019 The Strategy for Digitization of Agriculture and Rural Areas of the Republic of Bulgaria was adopted, which aims to turn Bulgarian agriculture and related agricultural business into a highly technological, sustainable, highly productive and attractive sphere of the global economy, which improves the living conditions of the agricultural producers, and rural areas in general. The priorities are to be defined and European and national funds earmarked for the implementation of the strategy and effective digitalization of Bulgarian agriculture in the period 2021-2027.

Experts assessment on the state and factors for development of the system for digitalization in agriculture and rural areas

Like most of the other EU member states, in Bulgaria there is not sufficient official (statistical, reporting, etc.) information on the state and development of agricultural digitalization. All this makes it difficult both to analyze the state and development of this important national system and to make comparative analyzes with other member states of the Union. For the purpose of this study analysis, in 2019 an expert assessment was made on the state and development of the system of knowledge, innovation and digitalization in Bulgarian agriculture, with the participation of 32 leading experts[2] from the scientific institutes of the Agricultural Academy (AA) and the Bulgarian Academy of Sciences (BAS), agrarian and other universities, National Agricultural Advisory Service (NAAS) and major professional organizations of farmers.

The majority of experts believe that the level of public spending and investments for digitalization in the

[2] The author is grateful to all experts for their involvement in the expertise, professional attitude and competent evaluations.

agricultural sector (81.2%), for agrarian research and for the implementation of agrarian innovations (62.5% each), and for agrarian consultations and training (43.7 %) is low or very low (Figure 8). Particularly large is the consensus among experts regarding the low level of public investment in digitalization in the agricultural sector, which is far behind the current needs of society and the industry. At the same time, none of the experts believe that the level of expenditures and investments is high in digitalization. Therefore, public expenditure and investment for the development of these important areas of the Agricultural Knowledge and Innovation System (AKIS) are to be significantly increased so that the main objectives of the CAP can be achieved in the next programming period.

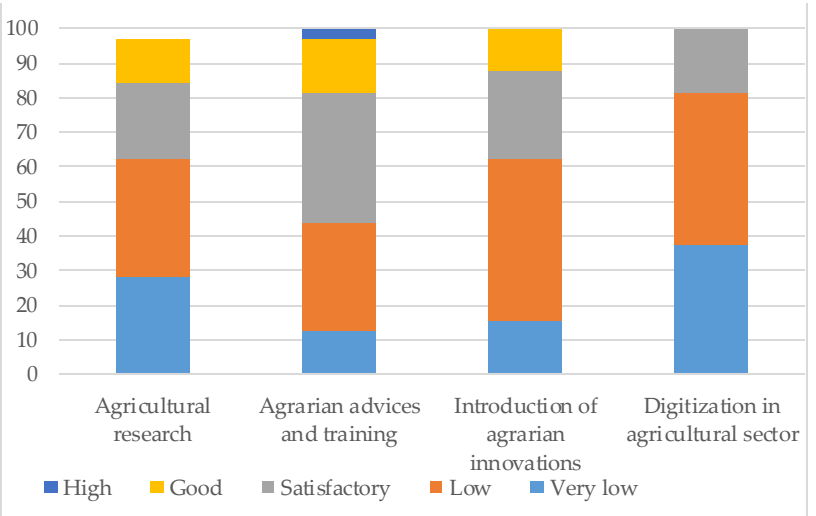

Figure 8. *Level of Public Expenditures and Investment in Agrarian Research, Agrarian Advices and Training, Introduction of Agrarian Innovation and Digitalization in Agrarian Sphere (%)*
Source: Experts assessment

A half of the experts evaluate the efficiency of public spending and investments in digitalization in the

agricultural sector as low or very low (Figure 9). However, one in four panelists is of the opinion that the payback in this area is satisfactory and the remaining quarter is good or high. The latter proves that, despite the extremely low amount of public investment in this area, their social efficiency is relatively high. Therefore, investments in this area have to be expanded in order to realize the existing high potential for improving the efficiency.

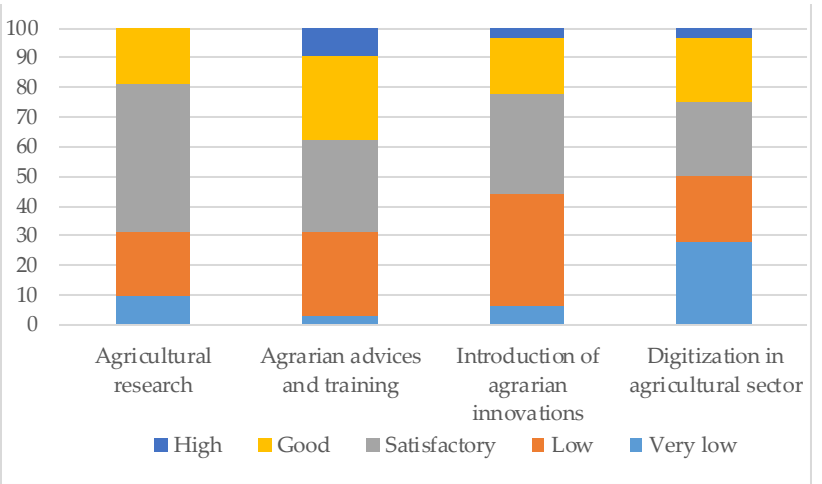

Figure 9. *Efficiency of Public Expenditures and Investment in Agrarian Research, Agrarian Advices and Training, Introduction of Agrarian Innovation and Digitalization in Agrarian Sphere (%)*
Source: Experts assessment

In terms of digital services and innovation, the universities (43.8%), and the media and Internet (40.6%) are cited by the majority of experts as most important for farmers' organizations (Figure 10). Among the most significant providers of digital information and services, according to a considerable number of experts, are private companies and consultants (31.2%), NAAS (28.1%), scientific institutes, suppliers of chemicals, technology, etc., and producer organizations (21.9% each).

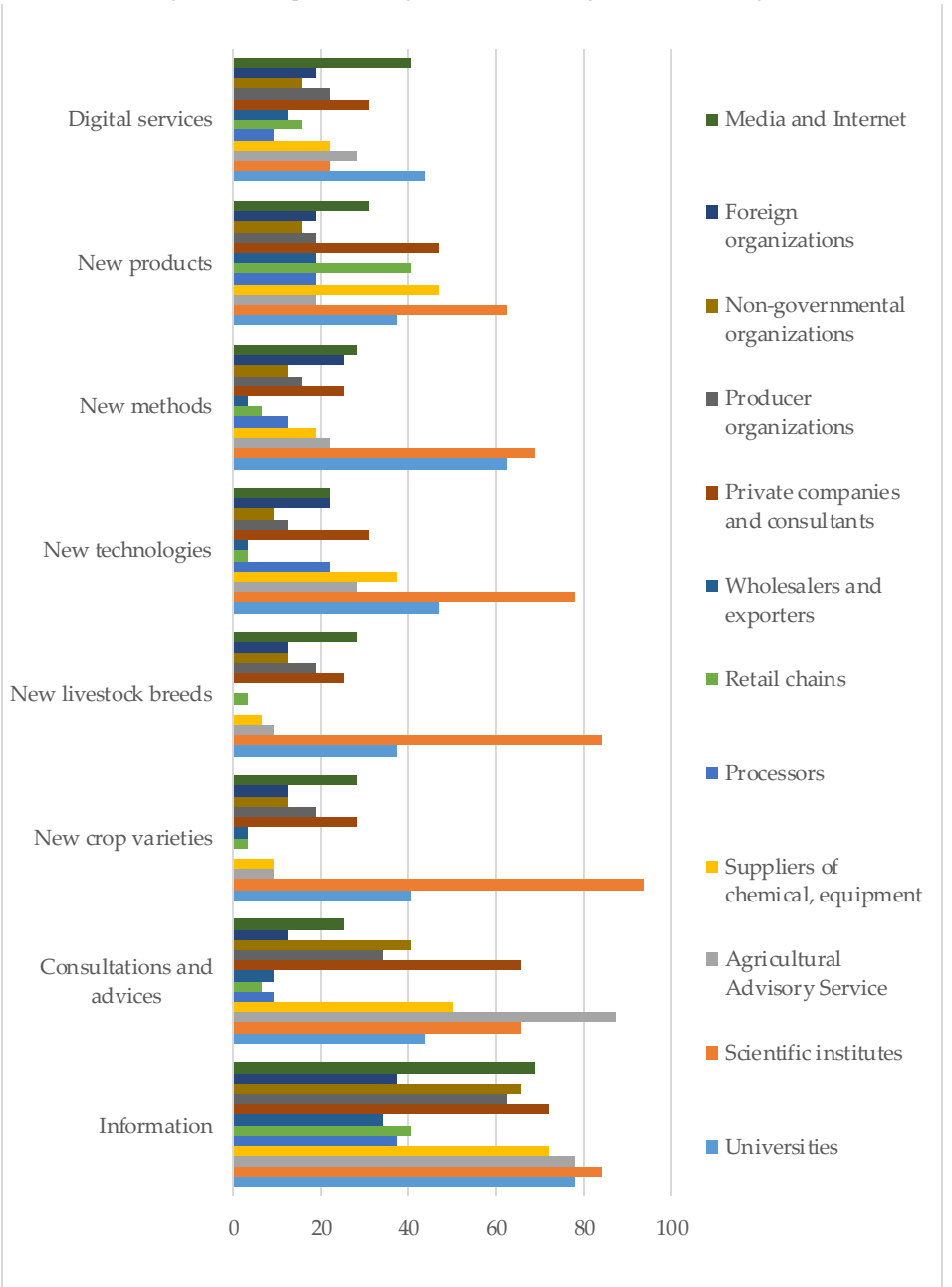

Figure 10. *Most Important Organizations Supplying Farms with Information, Consultations, Innovations and Digital Services (%)*
Source: Experts assessment

According to a large part of the panel of experts, the situation with farmers' real access to digital services, internet, software, etc. is unfavorable (Figure 11). Just over 53% of the experts consider this access to be inadequate or nonexistent, with one in four assessing it as satisfactory. Cardinal public support measures (investments, training, incentives, partnerships with the private sector, etc.) have to be also undertaken in this important area in order to overcome the lag in the digitalization of agricultural production and rural areas in the country.

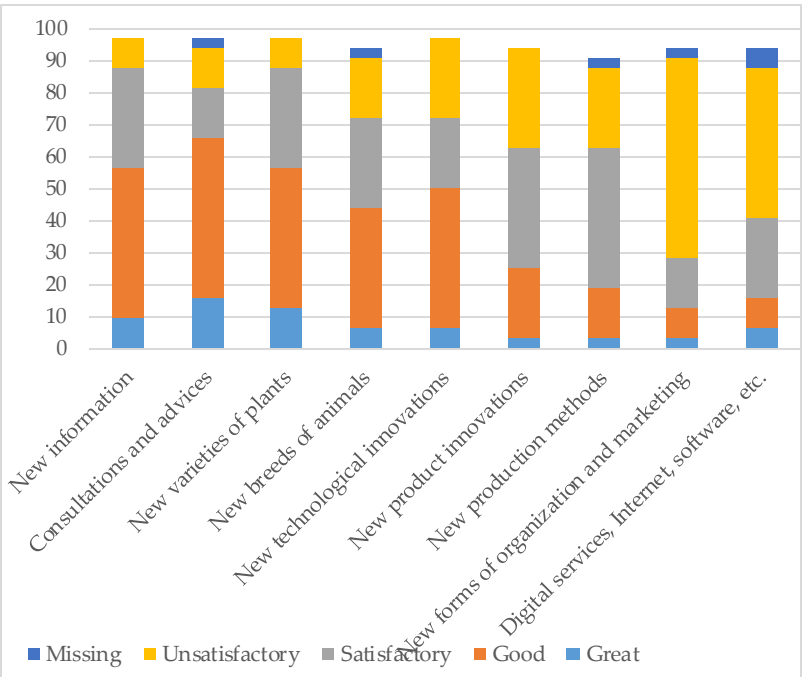

Figure 11. *Extent of Access of Farms to Information, Consultations, Innovations, and Digital Services (%)*
Source: Experts assessment

There is also a great variation in the degree of implementation of the different types of innovation in Bulgarian agriculture (Figure 12). A considerable part of the

expert panel is of the opinion that the degree of introduction of whole classes of innovations such as new methods of production, new forms of organization and marketing, technologies for precision agriculture, automation of processes, including the introduction of computers, Internet, software, etc. is unsatisfactory. Therefore, adequate public measures of support, stimulation, partnership, etc. Are to be taken in order to be able to exploit the great untapped potential for organizational, technological and product renewal of the sector.

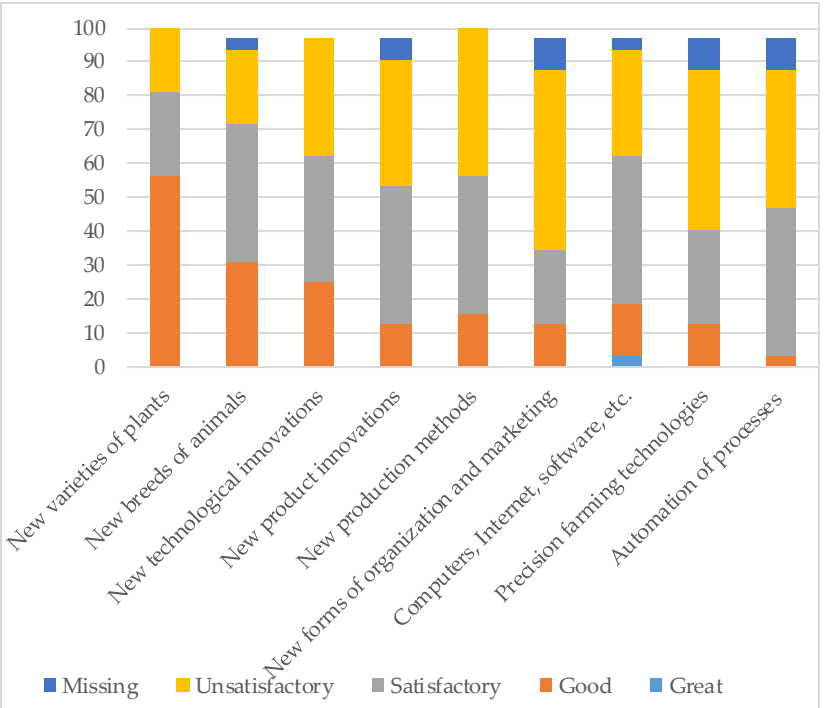

Figure 12. *Extent of Introduction of Different Type of Innovations in Bulgarian Farms (%)*
Source: Experts assessment

There is considerable differentiation in the degree of use of consultations and advices and in the introduction of

innovations of different kinds in individual sub-sectors of agriculture, in farms of different legal types and sizes, and in different regions of the country (Figure 13). According to the experts' evaluation, the digital technologies, software, etc. are being applied to the greatest extent in field crops (40.6%), and a smaller proportion of them in grain and livestock production (15.6% each). Other subsectors are lagging far behind in terms of implementation of digital technologies, software, etc. The later requires the implementation of specific measures to expand digitalization in the production and management of lagging sub-sectors.

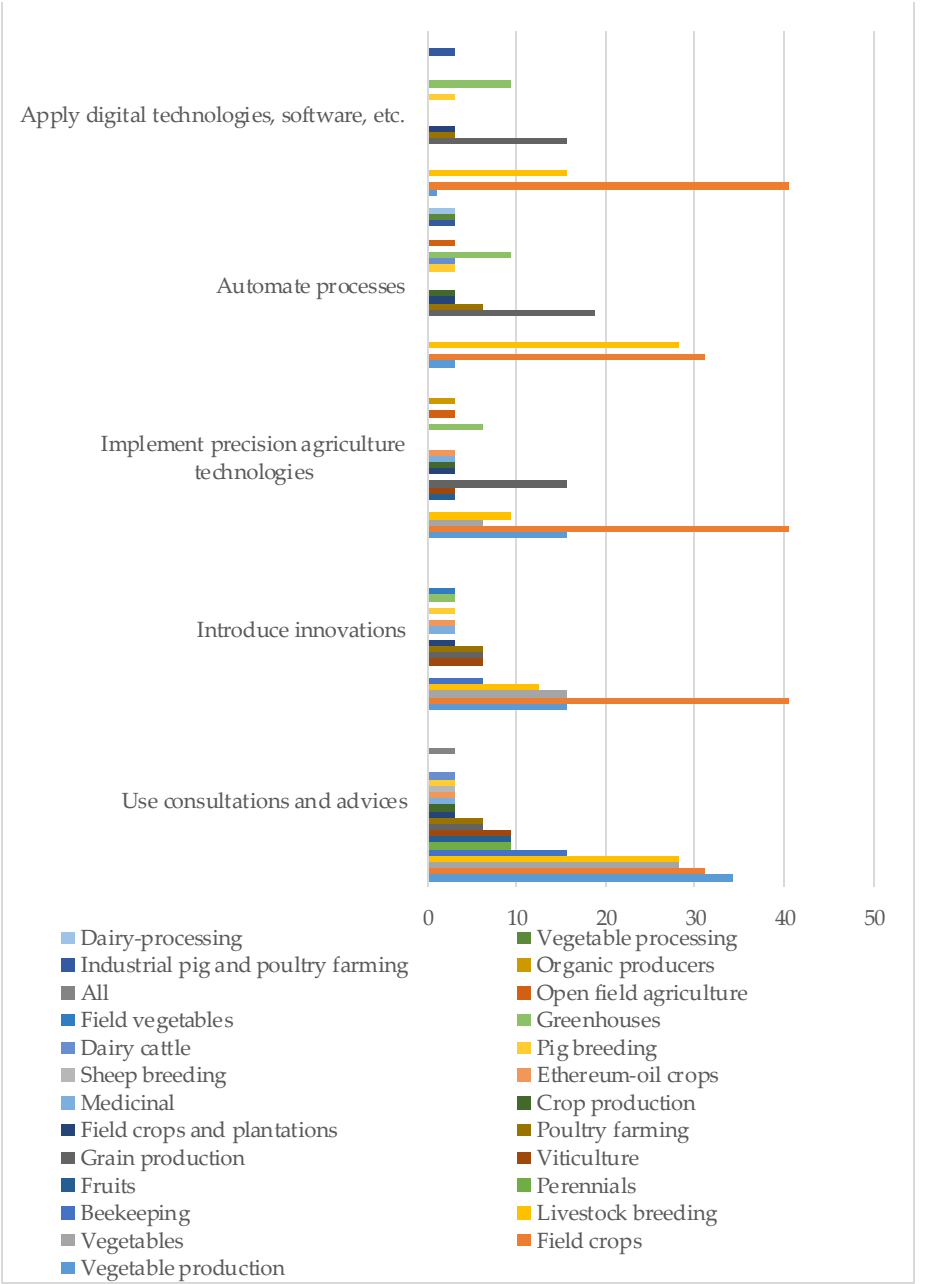

Figure 13. *Extent of Using of Advices and Consultations and Introductions of Different Type of Innovations in Individual Subsectors of Agriculture (%)*

There is also a great variation in the extent to which advices, consultations and innovations are introduced in farms of different types (Figure 14). Concerning the application of precision agriculture technologies, process automation and the implementation of digital technologies, software, etc., most experts believe that this is done mainly by legal entities (31.3%) and companies (21.9%), while other categories of farms are not active in these important areas. This requires the introduction of specific public measures to stimulate and support innovations in these new areas by all types of farms.

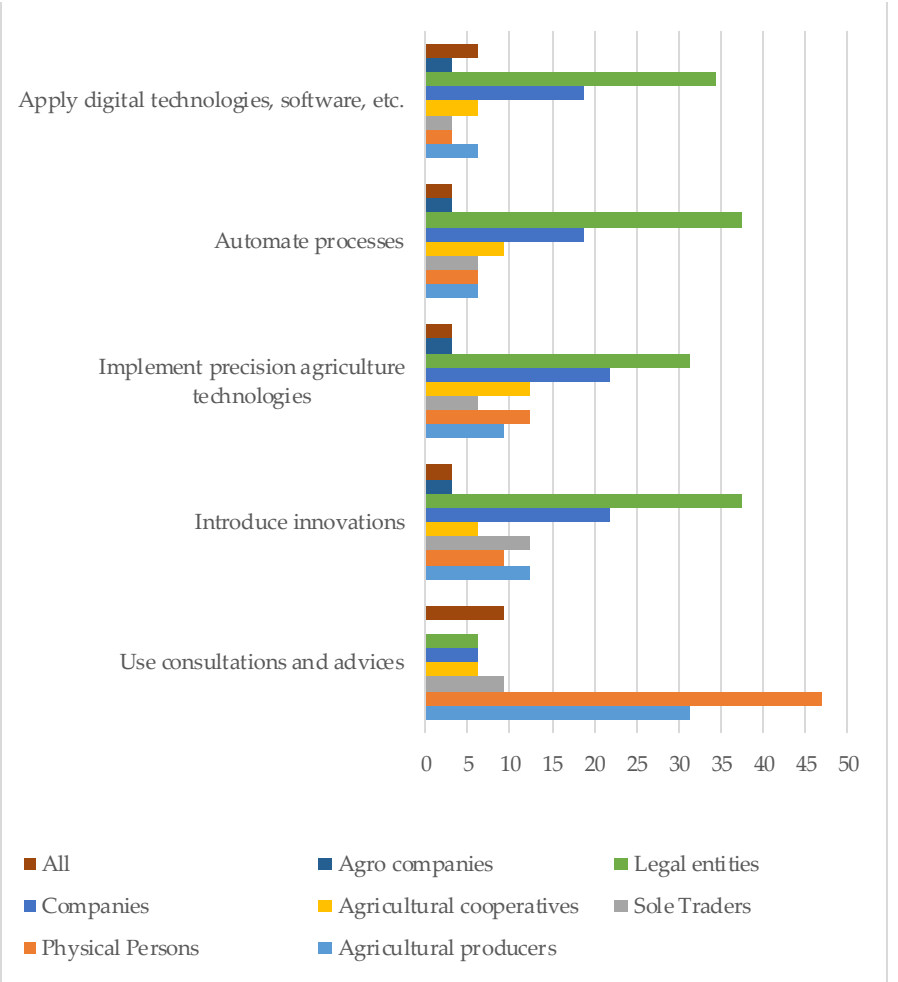

Figure 14. *Extent of Using of Advices and Consultations and Introductions of Different Type of Innovations in Farms of Different Juridical Type (%)*
Source: Experts assessment

There is also a great differentiation in the extent of using advices, consultations and introduction of innovations in farms of different sizes (Figure 15). The vast majority of experts are of the opinion that large holdings mostly innovate, apply precision agriculture technologies, automate

processes and apply digital technologies, software, etc. - 75%, 71,9%, 81,35 and 81,3% respectively. A relatively smaller number of the panel of experts believe that innovations generally and in the above-mentioned new areas are introduced by the medium-sized holdings. Therefore, public support and incentive measures should be taken to extend the introduction of farm innovations of all legal types and sizes in order to reduce the wide disparities in this regard.

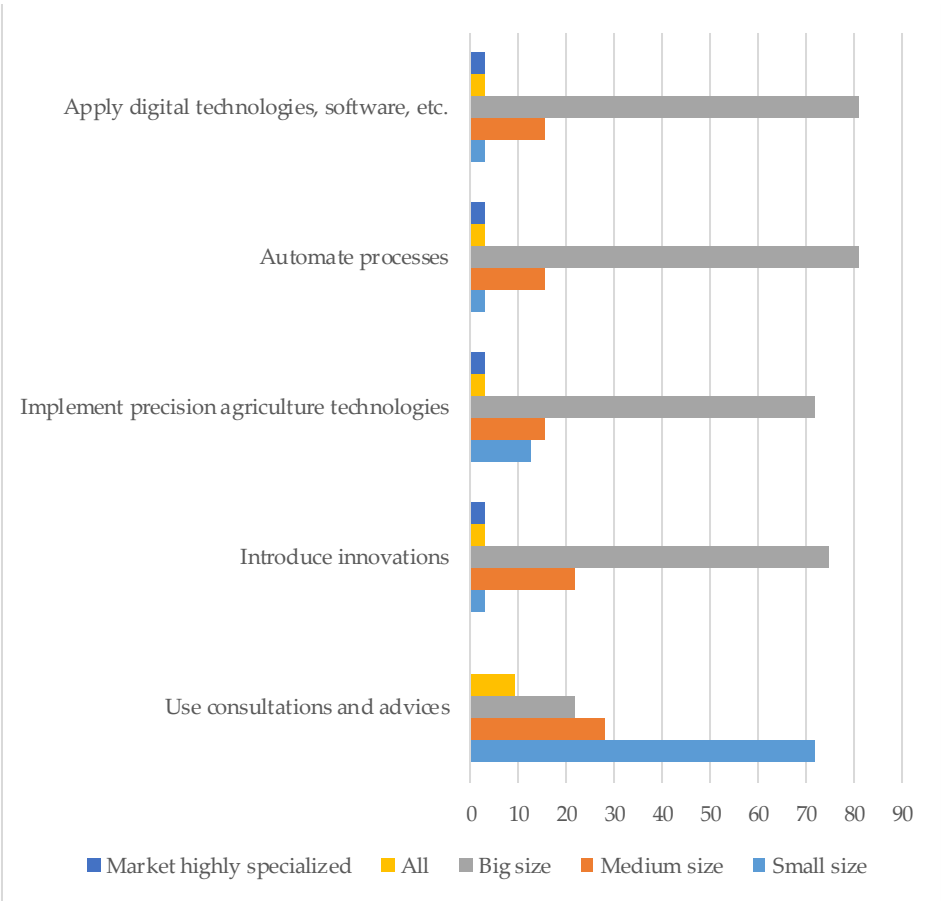

Figure 15. *Extent of Using of Advices and Consultations and Introductions of Different Type of Innovations in Farms of Different Size (%)*

Source: Experts assessment

Finally, there are differences in the degree of use of advices and consultations and the introduction of different types of innovations in different geographical regions of the country (Figure 16). According to the majority of experts, the largest adopter of innovations is the Northeast Region (37.5%), which is also a leader in the application of precision agriculture technologies (50%), process automation (37.5%), and the implementation of digital technologies, software, etc. (34.4%). A relatively smaller proportion of the experts also identify the South Central and Southeastern regions as intensive innovators (15.6% and 12.5% respectively), the application of precision agriculture technologies (15.6% and 12.5%), and process automation (15.6 each).

According to the large majority of experts, the degree of introduction of innovations in general and the application of modern technologies for precision agriculture, process automation, digitalization, etc. in other parts of the country is small. The later requires the introduction of specific measures for public support and partnership, for intensifying the introduction of innovations in general and in the latest trends such as advanced precision farming technologies, process automation and digitalization in other parts of the country. In this way it will be possible to overcome the great disparities in the development of the individual regions of the country.

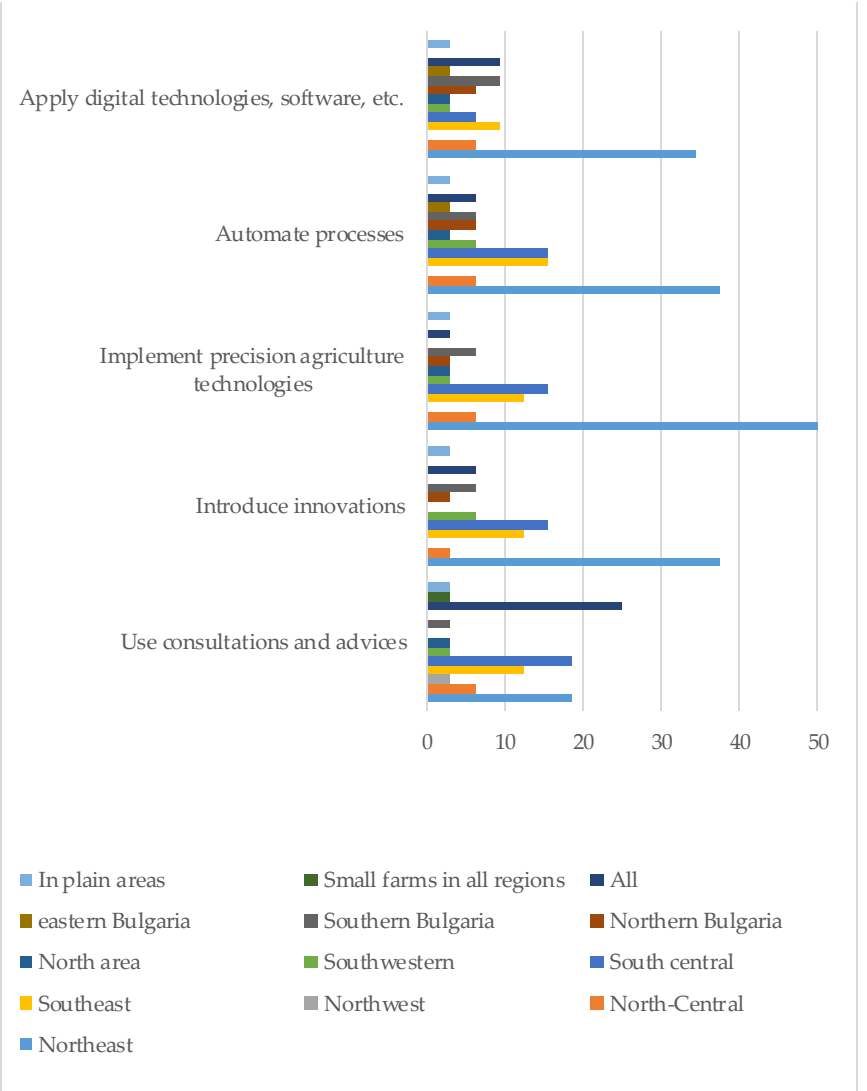

Figure 16. *Extent of Using of Advices and Consultations and Introductions of Different Type of Innovations Different Regions (%)*
Source: Experts assessment

The experts are greatly unanimous that the most significant factors (of great or very great importance) for improving the dissemination of knowledge, innovations and digitalization in agriculture and rural areas in Bulgaria at

this stage are: market (consumer) demand, prices, competition, and subsidies for new investments (84.4% each), as well as the activities of the Agricultural Advisory Service (81.3%) (Figure 17). Therefore, the support for markets development, and public support (subsidies) for advices and training and private investments are to be expanded.

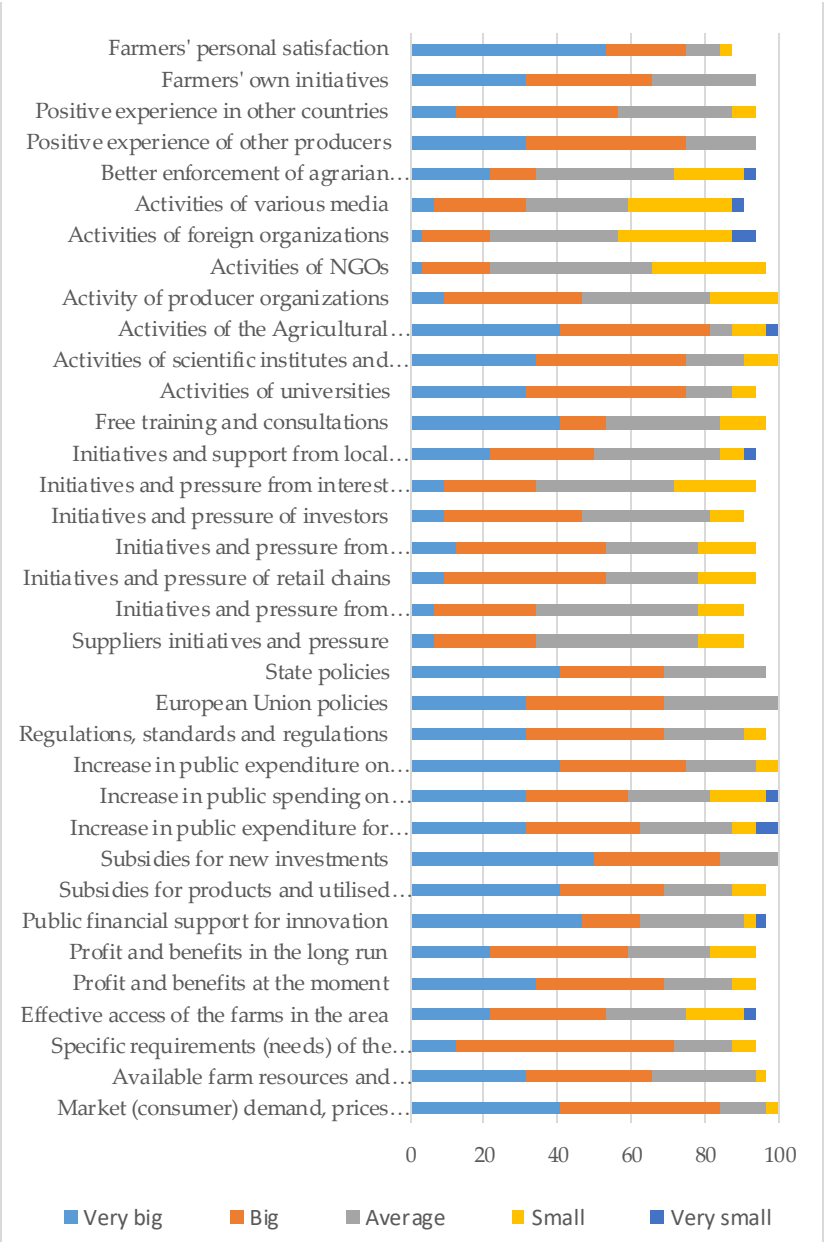

Figure 17. *Importance of Various Factors for Improving Dissemination of Knowledge, Innovation, and Digitalization of Agriculture and Rural Areas (%)*

Source: Experts assessment

Three quarters of the experts also believe that are important factors for improving dissemination of knowledge, innovations and digitalization in agriculture and rural areas are the increase in public spending on education, the activity of universities, the activities of scientific institutes and stations, the positive experience of other producers, and farmers' personal satisfaction.

A large number of experts also estimate that the specific requirements (needs) of the farms (71.9%), and the profit, and immediate benefits, the subsidies for products and utilized land, the regulations, standards and regulations, the EU policies and the policies of the state (68.8% each), are decisive for improving the diffusion of knowledge, innovations and digitization in agriculture and rural areas.

The majority of experts also give high rank to the available resources and capacities of the farms and farmers' own initiatives (65.6% each), as well as to the public financial support for innovations, and the growth in public expenditures for agricultural science (62.5%), the long-term profits and benefits, and the rise in public spending on agrarian advices (59.4% each), the positive experiences in other countries (56.3%), and the effective access of the farms and in the region, the initiatives and pressure of retail chains, the initiatives and pressure on wholesale traders and exporters, and the free training and consultancy (by 53.1%), for improving the situation in this respect.

All these factors for improving the existing situation are to be taken into account when improving the public support for the development of the knowledge sharing, innovations and digitalization system in the next programming period.

The final question to the panel of experts is the extent to which the achievement of the horizontal objective of dissemination of knowledge, innovations and digitalization in agriculture and rural areas in Bulgaria contributes to the achievement of the various objectives of the EU CAP. Most

experts believe that the successful achievement of the common objective contributes, to a large or very large extent, to the achievement of all the specific objectives of the EU CAP (Figure 18).

According to most experts, improving the dissemination of knowledge, innovations and digitalization in agriculture and rural areas contributes most to the specific objectives of the achieving sufficient agricultural incomes and sustainability (81.3%), and the enhancing market orientation and enhancement of competitiveness (78.1%).

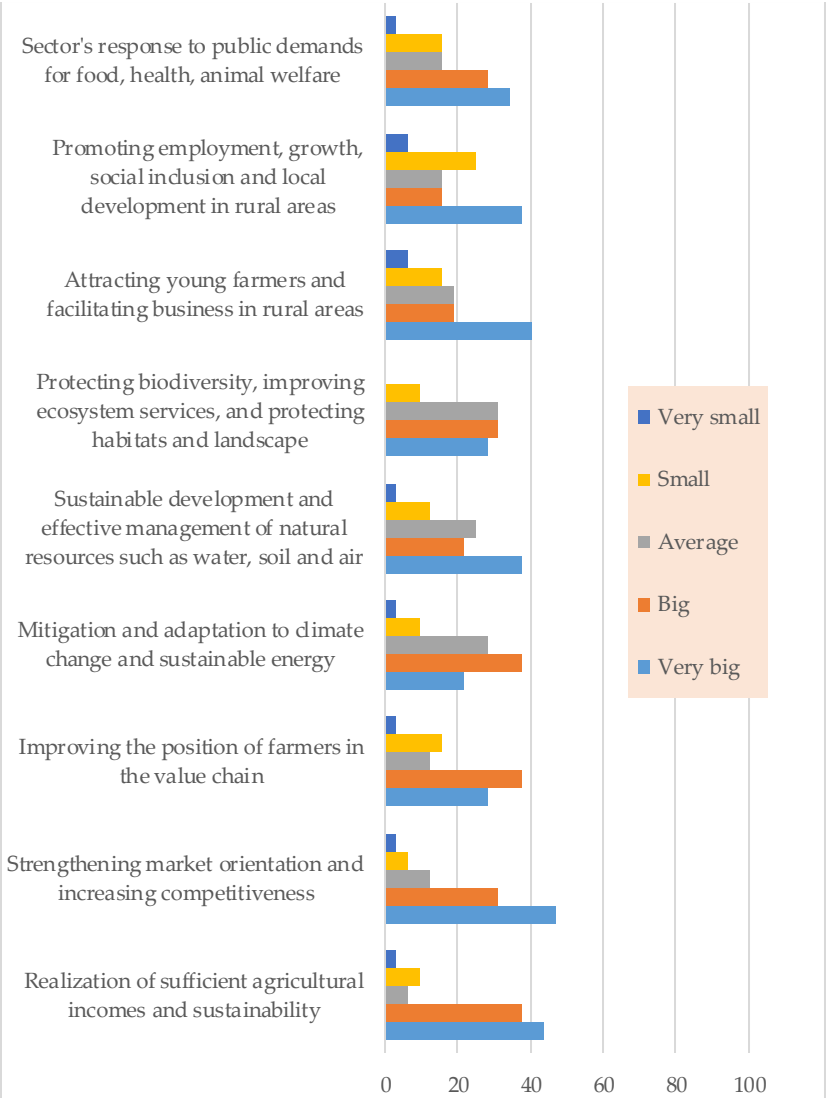

Figure 18. *Extent in which Sharing Knowledge Innovation and Digitalization in Bulgaria contributes for Realization of Different Goals of EU CAP (%)*

Source: Experts assessment

On the other hand, a comparatively smaller majority of the experts consider that improving the dissemination of knowledge, innovations and digitalization in agriculture and

rural areas contributes significantly to promoting employment, growth, social inclusion and local rural development (53.1 %).

All this proves that the effective measures are to be undertaken during the new programming period to realize the horizontal objective of the EU CAP for improvement of the dissemination of knowledge, innovations and digitalization in agriculture and rural areas, in order also to achieve successfully the specific objectives of the Union.

Conclusions

In recent years, there has been a significant improvement in the access of Bulgarian households to the Internet as a whole and in different regions, with large differences in access in densely populated areas and medium-urbanized and sparsely populated areas of the country. The number of people using the Internet to interact with public institutions or to order/purchase goods and services is also increasing significantly. However, compared to other EU countries, the development and use of e-government and commerce is much smaller, with Bulgaria taking the last place in this regard. The country is lagging far behind the other EU member states in terms of introduction of digital technologies in the economy and society, as in recent years the country ranking last in the EU for the integral Index for penetration of digital technologies in the economy and society.

There is a great variation in the degree of digitalization in different sub-sectors of agriculture, farms of different legal types and sizes, and in different regions of the country. Nearly half of the farmers in the country are not familiar with the content of digital agriculture, with only 14% of the farmers in the country using modern digital technologies on farms, mainly GPS navigation systems. According to the majority of Bulgarian farmers, the main obstacles and risks

in the introduction of digital technologies are employees' qualifications, the size of investments, unclear economic benefits, and data security.

The main areas in needs of actions by the state administration for the introduction of digital technologies are: support for measures for further qualification of employees, tax incentives for planning measures and digitization of activities, stimulation of young professionals, introduction of internationally recognized processes of standardization and certification, adapting data protection legislation, and ensuring high-quality and high-speed networks.

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4 Mapping sources, types and importance of ecosystem services from Bulgarian agriculture

Introduction

The products and the variety of direct and indirect benefits that humans receive from nature and the various ecosystems (agricultural, forest, grass, desert, rural, urban, mountain, lake, river, marine, coastal, etc.) are commonly known as "ecosystem services" (MEA). Agricultural ecosystems of different types and their specific “agro-ecosystem” services are among the most widespread in the world (EEA, 2015; FAO, 2016; INRA, 2017; UN, 2005). That is why the „new“ term agroecosystem “services” and “diservices”have been rapidly introduced in academic studies, and policies and business practices around the globe (Boelee, 2013; De Groot *et al.* 2002; Fremier *et al.* 2013; EEA, 2015; FAO, 2016; Gao *et al.* 2018; Garbach *et al.*, 2016; Habib *et al.*, 2016; Kanianska, 209; MEA, 2005; Nunes *et al.*, 2014; Novikova *et al.*, 2017; Marta-Pedroso *et al.*, 2018; Petteri *et al.*, 2013; Power, 2010; Scholes *et al.*, 2013; Tsiafouli *et al.*, 2017;

Van Oudenhoven, 2020; Wang *et al.*, 2013; Wood *et.al.*, 2015; Zhan, 2015). Nevertheless, in Bulgaria, like in many other countries, the studies associated with the agricultural contribution to ecosystem servicesof different type are at the beginning stage (Башев; Башев и др.; Казакова; Недков; Николов; Тодорова; Bachev; Grigorova and Kazakova; Todorova, ИАОС; Йорданов и др.; Чипев и др.).

Following the modern trends, huge degradation of (agro)ecosystems, and the "greening" of European Union policies (EC),official maping of ecosystem services in Bulgaria has been initiated in recent years (ИАОС). However, up to date the state of practival progression of the studies of agricultural services in the country is mostly at methodological level and very limited to general qlasification and qualitative "assessments"(ИАОС; Башев и др.; Bachev).Simultanously, there is a growing demands by farm manegers, policy makers, interests groups, public at large, etc. and needs for identification of scope, ammount and importance of diverse ecosystem services provided by country's agriculture.

This article tries to fill the gap and present initial results of a large scale studies on the structure and imporance of agroecosystm services in Bulgaria.

Methods and data

A modern framework for understaning and classification of agroecosysem services has been incorporated dividing them into different type - provisional (food for humans and animals, materials and resources for production and livelihoods, etc.), economic, a place for human life and activity, recreational, tourist, aesthetic, cultural, educational, informational, habitat, supporting, biodiversity conservation, water purification and retention, flood and fire protection, climate regulation, etc. (ИАОС; MEA).

By definition, „agrarian" ecosystems and "agrarian" ecosystem services are understood as ecosystem services related to agrarian (farming) „production", which as a rule is human (social) intervention in the natural order of nature.The hierarchy of agro-ecosystems and their services include multiple levels – from individual agricultural land plot/section, to land area, micro region etc. (Figure 1). *Indivial farm* is the main organizational unit in agriculture that manages resources, technologies and activities and produces a variety of products, including the positive and negative services of agro-ecosystems (Бачев; Bachev). The governance of agro-ecosystem services is an integral part of the management of agricultural farm, and the farm - the *first (lowest) level for agro-ecosystem services management*[1].

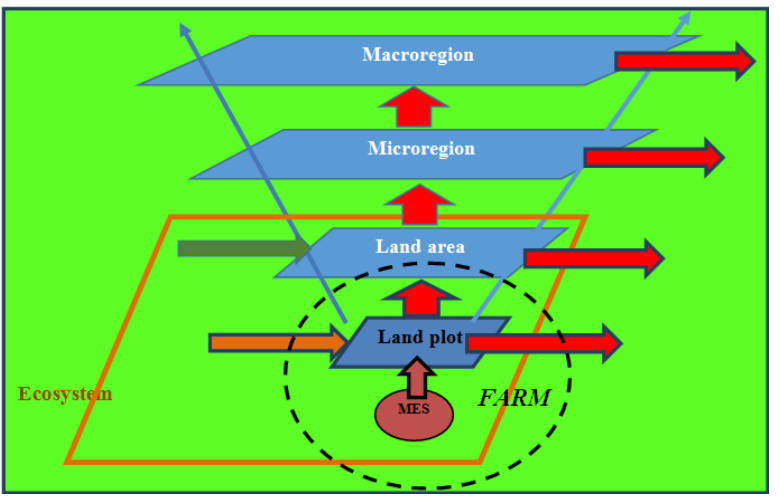

Figure 1. *Hierarchy of Agro-ecosystems in Bulgaria*
Notes: Blue– agro-ecosystem, **Red** – Agroecosystem Services, **MES** – Micro ecosystem located in the land plot, **Green**– Services of non-agrarian ecosystems, **Dash area** – Borders (activity) of individual farm
Source: author

[1] Farm borders rarely coincide with the (agro) ecosystem boundaries (Bachev).

In Bulgaria there is no available statisctical and other data on services provided by different type of agroecosystems.Since the individual farm is the basic unit of management of agrarian activities and provision of agro-ecostsem services, our study has focused on the (individual) *farm level* of maintainance and supply of ecosystem services. The agroecosystem services at a higher lever are evaluated as sum of agroecosystem services provided by the farms associated with the relevant (agro)ecosystems. Concequently, there is an unavoidable error from double accouning and/or uncalculated trade offs, sinergies, complementarities and contervercies of analised agroecosystem services of different type.

Literature review, experts opition and pilot studies have been used to identify the list of likely agroecosystem services maintained and supplied by agricultural farms in Bulgaria, and an option left for adding existing unlisted service(s).

The identification of the type, size, efficiency and importance of "produced" services of agro-systems is based on the assessments of the managers of 324 "typical" farms of different legal status, size, production specialization, ecological and geographical location. The survey was conducted in October 2020 with the assistance of the National Agricultural Advisory Service and leading professional organizations of agricultural producers in the country. Surveyed farms account for almost 0,5% of all registered agricultural producers in the country. The structure of studied holdings aproximately correspond to the real structure of farms in Bulgaria.

The accessments of the farm manares about type, ammount, and importance of agroecosystem services they maintain or prodice give good insights on the state and efficiency of agrpecosystem services in the country. The assimetry of information is quite big in the area and farmers are among the most informed actors about agricultural

effortsand contributiontoward(agro)ecosystem services. However, the managers estimates also reflects the "personal" (subjecive) knowlege and perceptions of the farmers on agroecosystem services, and their values, the efforts rather than output and impacts, etc. The objectivity of the study would partialy increasy during the next stage of the study when farmers assessments will be complemented with estimates of stakeholders, consumers, experts, etc.

Type and ammount of agroecosystem services

The conducted survey allowed to make a detailed map of the agro-ecosystem services of different types provided by agricultural producers, as well as to determine the structure and volume of the services of the agro-ecosystems of various types. The share of farms involved in activities related to the provision of agro-ecosystem service of a certain kind gives a good idea of the volume of "produced" service of that type.

The majority of Bulgarian farms participate in the "Production of products (fruits, vegetables, flowers, etc.) for direct human consumption" (59.3%), which is one of the main "services" of agro-ecosystems in the country (Figure 2). A significant part of the farms also "Produce raw materials (fruits, milk, etc.) for the food industry" (15.4%). Other "production" services in which a smaller part of the farms participate are "Production of animal feed" (8.6%), "Own processing of agricultural products" (6.17%), "Production of seeds, saplings, animals, etc. for farms"(4.3%) and "Production of raw materials for cosmetic, textile, energy, etc. industry"(3.09%).

Other "production" services of agroecosystems, in which a relatively small part of agricultural producers participate, are "Provision of services to other farms and agricultural organizations" (2.47%), "Provision of services to end users (riding, fruit picking, etc.)"(1.85%), "Provision of tourist and

restaurant services"(0.62%) and "Production of bio, wind, solar, etc. energy"(0.62%).

Other important services of the agro-ecosystems, in which "supply" a large part of the agricultural holdings participate, are "Hiring workers" (11.11%) and "Providing free access on the farm to outsiders" (10.49%).

Relatively many of the farms are also involved in the protection and preservation of technological, biological, cultural and other heritage - "Preservation of traditional crops and plant varieties" (6.17%), "Preservation of traditional species and breeds of animals" (7.41%), "Preservation of traditional methods, technologies and crafts" (6.17%), "Preservation of traditional products"(6.17%), "Preservation of traditional services"(5.55%), "Preservation of traditions and customs"(3.7%) and "Preservation of historical heritage"(1.23%).

A major part of agro-ecosystem services consists in preserving, restoring and improving the elements of the natural environment - soil, water, air, gene pool, landscape, plants and animals, etc. The activity of a large part of the agricultural holdings is aimed at the production of this type of agro-ecosystem services - "Disease control (measures)" (24.69%), "Pest control (measures)" (19.75%), "Protection of natural biodiversity"(18.52%), "Protection and improvement of soil fertility"(16.67%), "Protection from soil erosion"(13.58%), "Protection and improvement of soil purity"(12.34%), "Protection of surface water" (11.73%)," Protection of groundwater purity" (9.88%)," Ffire protection(measures)"(8.64%), and "Protection of plant and/or animal gene pool" (8.02%).

A relatively smaller part of the farms are also included in "(Measures for) water conservation and saving" (5.55%), "(Measures for) regulation of the correct outflow of water" (4.32%), "Preservation of air quility"(4.32%),"Preservation of traditional scinery and landscape"(3.7%), "Improvement

(aesthetics, aroma, land use, etc.) of scinery and landscape "(3.09%), "(Measures for) regulation and improvement of the microclimate"(3.09%), "Flood protection (measures)" (2.47%), and "Greenhouse gas emission reduction (measures)" (2.47%), and "(Measures) for storm protection"(1.85%).

One of the essential services of agroecosystems is the recovery and recycling of "waste" from various activities in the sector and other industries. The main activity of many farms in this regard is "Use of manure on the farm" (13.58%), and to a lesser extent "Reuse and recycling of waste, composting, etc." (3.09%) and "Use of sludge from water treatment on-farm" (0.62%).

Agri-ecosystems also make a significant contribution to training farmers and non-agricultural agents, conducting scientific experiments, demonstrating innovation, and so on. In such educational, scientific and innovative services participate a smaller part of the agricultural producers - "Training and advice of other farmers" (4.32%), "Training of students, consumers, etc." (1.85%), "Demonstration of production, technologies, innovations, etc."(1.85%) and "Conducting a scientific experiment "(1.85%).

Agroecosystems also contribute to the "Protection and improvement of non-agricultural (forest, lake, urban, etc.) ecosystems" with 4.32% of farms in the country engaged in such efforts.

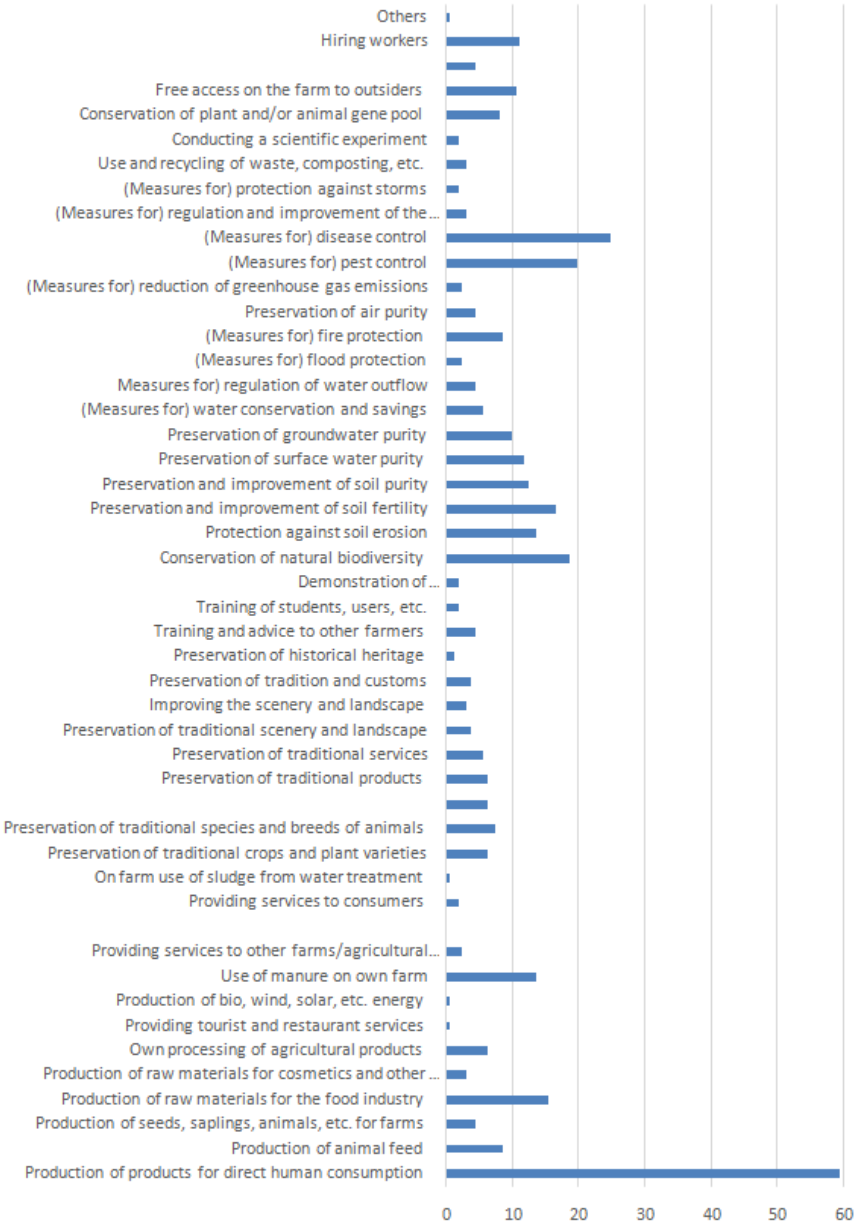

Figure 2. *Share of farms participating in (supporting) the preservation or production of different types of agro-ecosystem services in Bulgaria (percentages)*

Source: Survey of agricultural producers, 2020

The extent of participation of supplying farms in the presevation or production of agro-ecosystem services is not equal. For most agri-ecosystem services, the holdings involved in the activities do so "To a large extent' (Figure 3). Therefore, "permanent" investments in agri-ecosystem services and "specialization" in the provision of agro-ecosystem services of a certain type to participating farms can be considered.

In some agro-ecosystem services, the share of farms involved to a large and small extent is equal - for example in the use of manure on the farm, the provision of services to other farms and agricultural organizations, (flood protection) measures, and the hiring of workers. Therefore, a significant proportion of farms are either in the process of initially "entering" (testing, studying, adapting, etc.) in the related agro-ecosystem services, or participate in this supply as ancillary or related to the main activity.

With regard to three main types of agro-subsistence services, most of the farms involved in their supply do so to a small extent – on farm using sludge from water treatment, training of students, consumers, etc., and use and recycling of waste, composting, etc. This is a sign of either the initial entry into or exit from this activity, or the inefficiency of its further expansion (intensification) by practicing farms.

The unequal participation of farmers in the provision of agro-ecosystem services of different types and unlike degrees of involvement in such activities shows the need to take measures to improve, diversify and intensify this activity through training, information, exchange of experience, public incentives, etc.

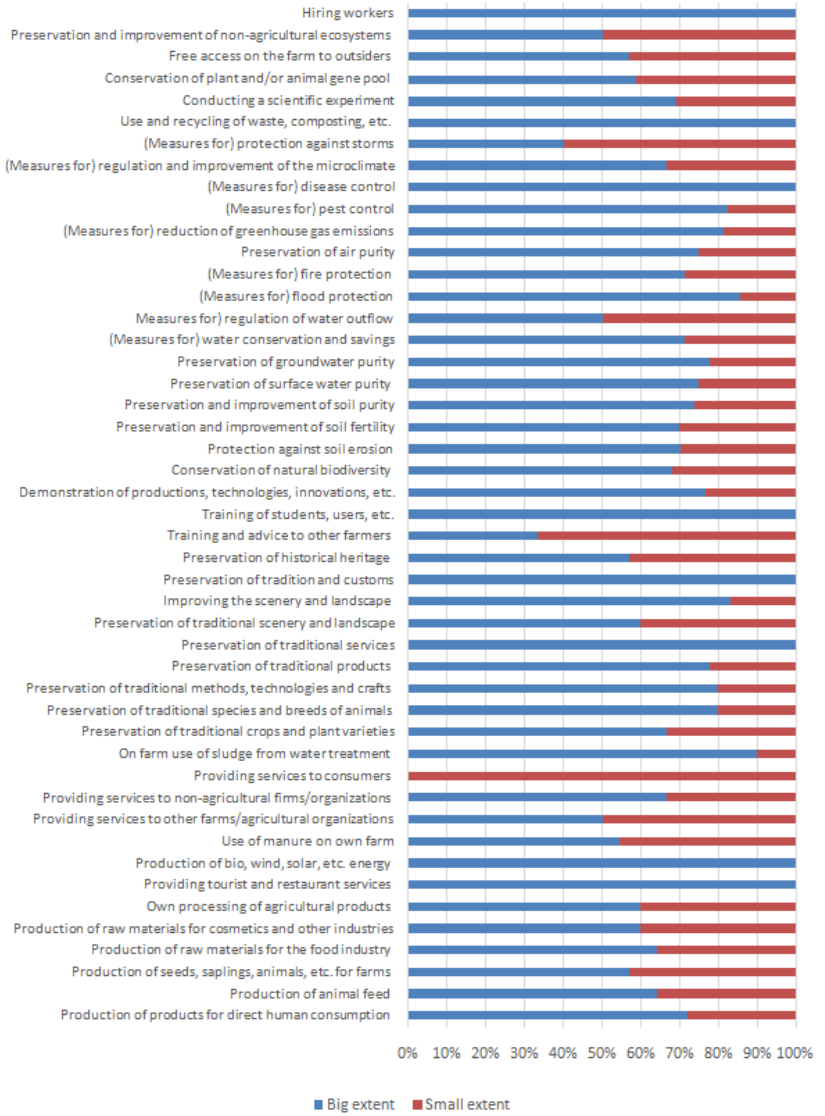

Figure3. *Extent of participation (support) of farms in preservation or production of various types of agro-ecosystem services in Bulgaria*
Source: Survey of agricultural producers, 2020

There are significant differences and deviations from the average level in the participation of agricultural holdings in the preservation and supply of agro-ecosystem services in

the main geographical and agricultural regions of the country (Figure 4).

North-western region surpasses the other regions in terms of share of farms contributing to agro-ecosystem services for production of raw materials for the food industry (17.5%), own processing of agricultural products (12.5%), provision of tourist and restaurant services (2.5%), provision of services to end-users (5%), and protection and improvement of soil fertility (22.5%).

The North Central region is a champion in terms of farm participation in the preservation of traditional crops and plant varieties (16.67%), preservation of traditional methods, technologies and crafts (10%), preservation of traditional products (10%), (measures for) fire protection (13.33%) and protection of plant and /or animal gene pool (13.33%).

The Northeast region is the largest supplier of the following agroecosystem services - production of animal feed (15.79%), production of seeds, saplings, animals, etc. for farms (10.53%), production of raw materials for cosmetics, etc. industries (15.79%), production of bio, wind, solar, etc. energy (5.26%), (measures for) pest control (42.1%), (measures for) disease control (47.37%), conducting a scientific experiment (5.26%), providing free access on the farm to outsiders (15.79%) and hiring workers (21.05%).

Southwestern region has a leading position only in terms of three agroecosystem services - production of animal feed (13.33%), provision of services to other farms and agricultural organizations (6.67%) and conservation of traditional species and breeds of animals (13.33%).

South Central region is the largest producer of many agro-ecosystem services - production of products for direct use byhuman (82.35%), use of manure on the farm (23.53%), preservation of traditional species and breeds of animals (14.7%), preservation of traditional methods, technologies and crafts (11.76%), preservation of traditional services

(14.7%), preservation of traditional scinery and landscape (11.76%), improvement of scinery and landscape (8.82%), preservation of tradition and customs (8.82%)), training and advice of other farmers (11.76%), training of students, consumers, etc. (8.82%), demonstration of productions, technologies, innovations, etc. (2.94%), protection of natural biodiversity (26.47%), protection against soil erosion (29.41%), protection and improvement of soil fertility (26.47%), protection and improvement of soil purity (20.59%), protection of purity of surface waters (20.59%), protection of groundwater purity 17.65%, (measures for) conservation and savings of water (14.7%), protection of air purity (11.76%), (measures for) reduction of greenhouse gas emissions (8.82%), (measures for) pest control (23.53%), (measures for) control of diseases (35.29%), (measures for) regulation and improvement of the microclimate (11.76%), (measures for) protection against storms (8.82%), use and recycling of waste, composting, etc. (14.7%), conducting a scientific experiment (5.88%), protection of plant and /or animal gene pool (11.76%), protection and improvement of non-agricultural ecosystems (8.82%) and employment of workers (20.59%).

Southeast region is a leader in terms of production of products for direct human consumption (66.67%), protection of natural biodiversity (29.17%), protection against soil erosion (25%), (measures to) regulate the proper outflow of water (8.33 %) and fire protection (measures) (12.5%).

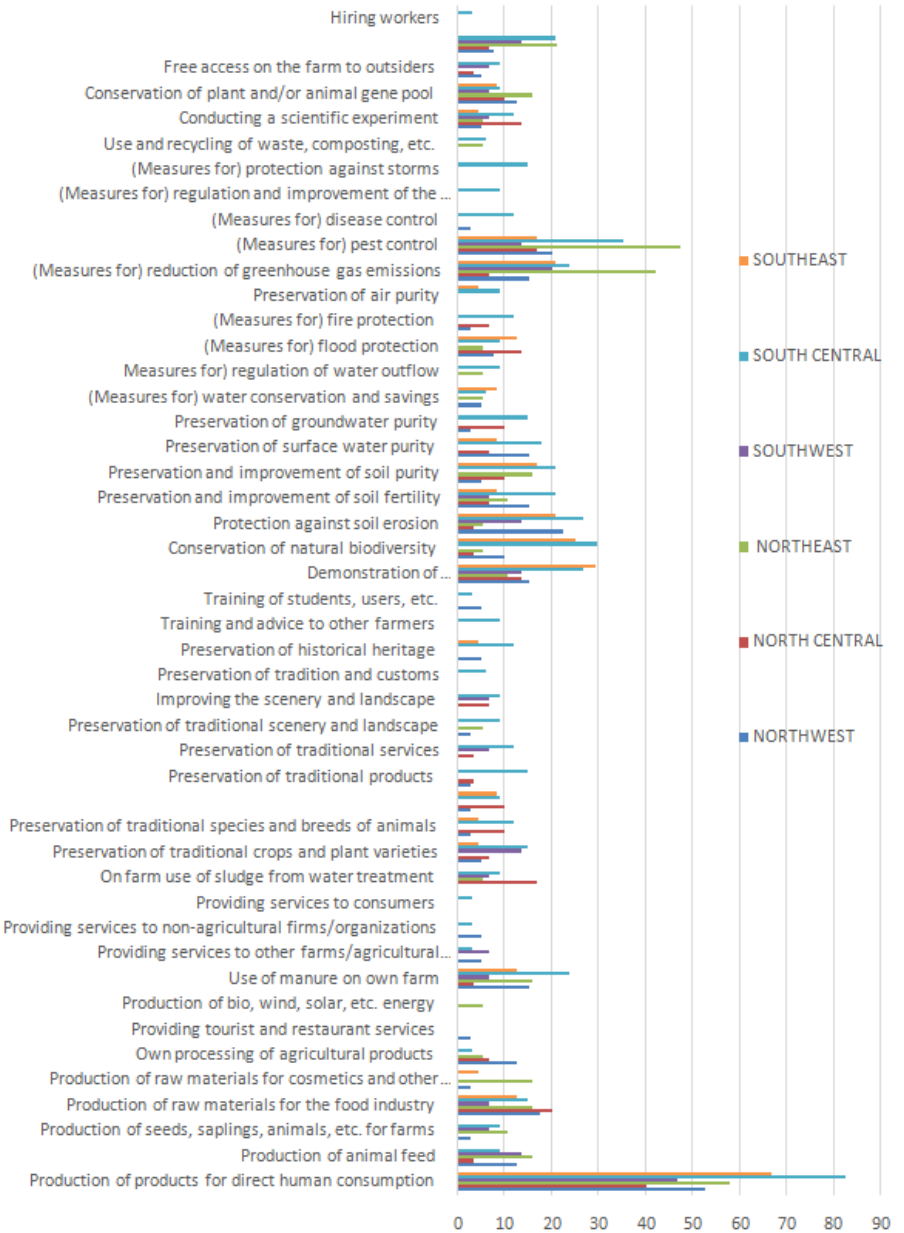

Figure 4. *Share of farms involved (supporting) the preservation or production of various types of agro-ecosystem services in different regions of Bulgaria (percentages)*

Source: Survey of agricultural producers, 2020

The large specific ecosystems in the country also differ significantly in the structure of the dominant agro-ecosystem services and in the share of the farms involved in their preservation and provision (Figure 5).

For example, the agro-ecosystem Western Stara Planina is a leader in the share of farms engaged in agro-ecosystem services related to the production of animal feed (11.54%), own processing of agricultural products (15.38%), provision of services to other farms and agricultural organizations (3.85%) and provision of services to end users (7.69%).

Another studied mountenous agro-ecosystem the Rhodope Mountains is leading in the share of agricultural producers involved in the production of products for direct human consumption (78.95%), production of raw materials for the food industry (21.05%), use of manure on the farm (26.32%), preservation of traditional species and breeds of animals (10.53%), preservation of traditional methods, technologies and crafts (10.53%), preservation of traditional services (21.05%), preservation of traditional scinery and landscape (10.53%), improvement of scinery and landscape (5.26%), preservation of historical heritage (5.26%), education of students, consumers, etc. (5.26%), protection of natural biodiversity (26.32%), protection from soil erosion (31.58%), protection and improvement of soil fertility (26.32%), protection of air purity (10.53%), (measures of) reduction of greenhouse gas emissions (5.26%), (measures for) regulation and improvement of the microclimate (15.79%), use and recycling of waste, composting, etc. (10.53%), protection of plant and /or animal gene pool (15.79%), and protection and improvement of non-agricultural ecosystems (5.26%).

Agri-ecosystem Danube Plain occupies leading positions in terms of the share of farms involved in the production of raw materials for the food industry (26.92%), provision of services to other farms and agricultural organizations (3.85%), preservation of traditional crops and plant varieties

(7.69%), preservation of traditional species and breeds of animals (11.54%), preservation of traditional methods, technologies and crafts (11.54%), preservation of traditional products (11.54%), preservation of traditions and customs (7.69%), demonstration of productions, technologies, innovations, etc. (3.85%), protection and improvement of soil purity (19.23%), protection of groundwater purity (23.08%), (measures for) storage and saving of water (15.38%), (measures for) fire protection (15.38%), protection of plant and /or animal gene pool (15.38%), free access on the farm to outsiders (19.23%) and hiring of workers (11.54%).

The agro-ecosystem of Dobrudja surpasses the others in terms of production of seeds, saplings, animals, etc. for farms (5.55%), production of raw materials for cosmetics and other industries (5.55%), flood protection (measures) (5.55%), fire protection (measures) (16.67%), pests control(measures) (50%), (measures for) disease control (55.56%), conducting a scientific experiment (5.56%), free access on the farm to outsiders (16.67%) and protection and improvement of non-agricultural ecosystems (5.56 %).

The Thracian Lowland agroecosystem is at the forefront in terms of the share of participating farms in the production of products for direct human consumption (80%), on-farm use of sludge from water treatment (4%), conservation of natural biodiversity (28%), conservation of surface water purity (20%), storm protection(measures) (4%) and employment of workers (12%).

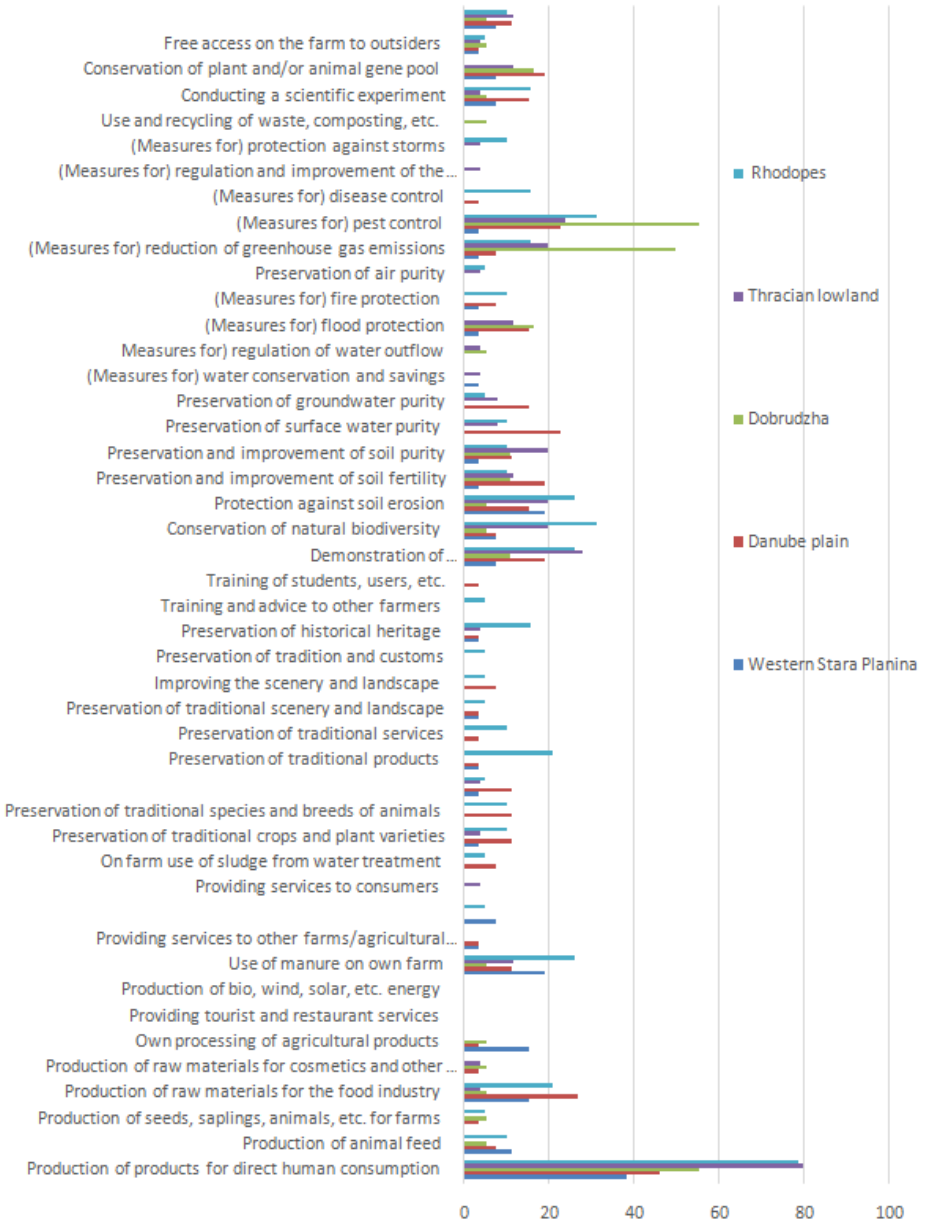

Figure5. *Share of farms participating (supporting) the presevation or production of various types of agro-ecosystem services in specific ecosystems of Bulgaria (percentages)*

Source: Survey of agricultural producers, 2020

Farmers in the principle ecosystems of the country are also involved to varying degrees in the preservation and production of agro-ecosystem services (Figure 6). Agroecosystems in a predominantly plain region of the country are leading in the number of participating farmers in terms of production of products for direct human consumption (63.38%), provision of services to other farms /agricultural organizations (4.22%), protection from soil erosion (15.49%), protection and improvement of soil fertility (18.31%), (measures for) pest control (26.76%) and (measures for) disease control (30.98%).

Agroecosystems in the plain-mountenouse regions of the country outperform the rest in terms of the share of farmers involved in the production of raw materials for cosmetics and other industries (11.43%), preservation of traditional crops and plant varieties (11.43%), preservation of traditional methods, technologies and crafts (11.43%), protection of natural biodiversity (22.86%), pest control(measures) (25.71%) and employment of workers (17.14%).

Agroecosystems in mostly mountainous regions of the country are in the best comparative position in terms of the inclusion of farms for preservation of traditional methods, technologies and crafts (11.54%), preservation of traditional services (15.38%), preservation of tradition and customs (7.69 %), preservation of historical heritage (3.85%), education of students, consumers, etc. (7.69%), demonstration of productions, technologies, innovations, etc. (7.69%), (measures for) conservation and savings of water (7.69%), (measures for) regulation and improvement of the microclimate (11.54%) and hiring of workers (15.38%).

The share of farms in agro-ecosystems in Protected areas and territories is superior to other types of agro-ecosystems in terms of production of animal feed (10.71%), production of seeds, saplings, animals and others. for farms (10.71%), production of raw materials for the food industry (25%),

provision of tourist and restaurant services (3.57%), use of manure on the farm (21.43%), preservation of traditional crops and plant varieties (25%), conservation of traditional species and breeds of animals (10.71%), conservation of traditional scinery and landscape (10.71%), conservation of natural biodiversity (32.14%), conservation of air purity (14.29%), (measures for) regulation and improvement of the microclimate (10.71%) and protection of plant and/or animal gene pool (17.86%).

The agro-ecosystems in mountenouse regions with natural constraints occupy leading positions in the country in terms of the share of the participating farms in the production of many agro-ecosystem services - production of products for direct human consumption (71.43%), production of animal feed (10.71%), seed production, saplings, animals, etc. for farms (10.71%), production of raw materials for the food industry (32.14%), own processing of agricultural products (17.86%), provision of tourist and restaurant services (3.57%), use of manure on the farm (25%), provision of services to end users (3.57%), preservation of traditional crops and plant varieties (17.86%), preservation of traditional species and breeds of animals (17.86%), preservation of traditional methods, technologies and crafts (14.28%), preservation of traditional products (17.86%), preservation of traditional scinery and landscape (10.71%), improvement of scinery and landscape (10.71%), preservation of tradition and customs (7.14%), training and advice of other farmers (10.71%), demonstration of production, technology, innovation, etc. (7.14%), protection of natural biodiversity (35.71%), protection against soil erosion (28.57%), protection and improvement of soil fertility (32.14%), protection and improvement of soil purity (25%), protection of purity of surface waters (21.43%), (measures for) regulation of outflow of water (10.71%), protection of air purity (14.28%), (measures for) reduction of greenhouse gas

emissions (10.71%), (measures for) protection from storms (7.14%), conducting a scientific experiment (7.14%), and providing free access on the farm to outsiders (17.85%).

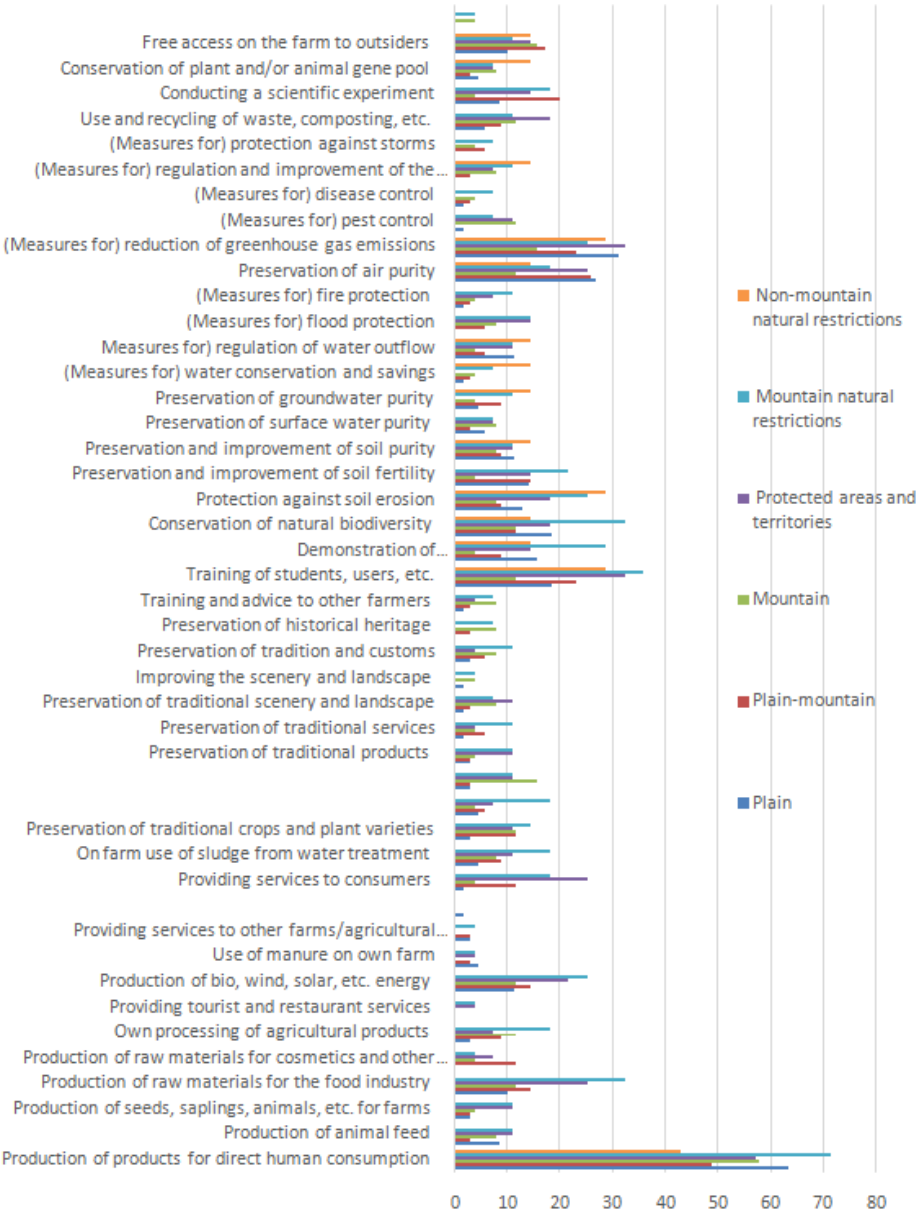

Figure 6. *Share of farms participating (supporting) the preservation or production of various types of agro-ecosystem services in the principle agro-ecosystems of Bulgaria (percentages)*
Source: Survey of agricultural producers, 2020

On the other hand, farmers in ecosystems in non-mountainous regions with natural constraints participate in the conservation and supply of a limited range of agro-ecosystem services, outperforming other agro-ecosystems in some important areas such as conservation of natural biodiversity (28.57%), protection and improvement of soil purity (28.57%), protection of the purity of the groundwater (14.28%), (measures for) regulation of the proper outflow of water (14.28%), (measures for) protection against floods (14.28%), (measures for) protection against fires (14.28%), use and recycling of waste, composting, etc. (14.28%) and protection and improvement of non-agricultural ecosystems (14.28%).

Significant differences in the preservation and provision of services of different types in the main specific and principled ecosystems of the country, and in different geographical and agricultural areas is a sign of different potential and "specialization" in supplying the main types of services from different agro-ecosystems in the country as well as of the uneven development of this activity among the agricultural producers in the different regions and ecosystems of the country.

The share of farms with different production specialization involved in the preservation and supply of agro-ecosystem services gives a good idea of the contribution of different types of production and specific agro-ecosystems to agro-ecosystem services of different types (Figure 7). For example, agro-ecosystems with field crops contribute to a relatively smaller number of agro-system services compared to other production systems in the country. However, this specific type of agro-ecosystem is superior to the others in two respects - in terms of the share of farms involved in the production of animal feed (21.43%) and fire protection (measures) (21.43%).

The vegetables and mushrooms sector is leading in the country in terms of the share of participating farms in the production of products for direct human consumption (83.33%), on-farm use of sludge from water treatment (5.55%), (measures of) storageand savings of water (11.11%), pest control (measures) (38.89%) and disease control(measures) (44.44%).

The perennials sector provides a wide variety of agro-ecosystem services, but surpasses the others only in the share of farms participating in the provision of tourist and restaurant services (1.75%) and protection against soil erosion (21.05%).

The grazing animals sector occupies leading positions in the country in terms of the share of farmers contributing to a number of agro-ecosystem services - production of raw materials for the food industry (45.45%), own processing of agricultural products (18.18%), use of manure on the farm %), provision of services to end users (9.09%), conservation of traditional species and breeds of animals (27.27%), conservation of traditional services (27.27%), protection of surface water purity (27.27%), protection of purity of air (18.18%), (measures for) reduction of greenhouse gas emissions (9.09%), use and recycling of waste, composting, etc. (18.18%), protection of plant and/or animal gene pool (27.27%), granting free access to the territory of the farm to outsiders (18.18%) and protection and improvement of non-agricultural ecosystems (27.27%).

The specialized holdings in pigs, poultry and rabbits contribute to a very limited number of agro-ecosystem services, but in several respects occupy leading positions in the country where every third producer is involved in the protection and improvement of soil purity, protection of groundwater purity, (measures for) regulating the proper flow of water, and hiring workers.

The field crops sector surpasses the others only in terms of preservation of traditional crops and plant varieties (9.09%), while those specialized in mixed livestock for two types of agroecosystem services - providing services to other farms and agricultural organizations (7.69%) and regulation and improvement of the microclimate (15.38%).

Specialized in mix crop and livestock farms participate in the supply of a wide range of agro-ecosystem services, as a relative number of participants occupy a leading position in the production of seeds, saplings, animals, etc. for farms (14.81%), preservation of traditional scinery and landscape (14.81%), improvement of scinery and landscape (11.11%), preservation of historical heritage (7.41%), training and advice of other farmers (14.81%), protection and improvement of soil fertility (25.92%), (measures for) storage and saving of water (11.11%), (measures for) protection against storms (7.41%) and conducting a scientific experiment (7.41%).

Farms specializing in bee families are characterized by the highest share of participants in the production of raw materials for cosmetics and other industries (10%), preservation of traditional species and breeds of animals (30%), preservation of traditional methods, technologies and crafts (40%), preservation of traditional products 20%, preservation of tradition and customs (20%), demonstration of productions, technologies, innovations, etc. (10%) and conservation of natural biodiversity (30%).

Significant sectoral differences in the preservation and supply of services of different types are a sign of both the different "specialization" in the supply of the main types of services from farms with different specializations and the uneven development of this activity. The later requires further research into the links between specialization and agri-ecosystem services, as well as measures to expand and diversify this activity across all farm groups.

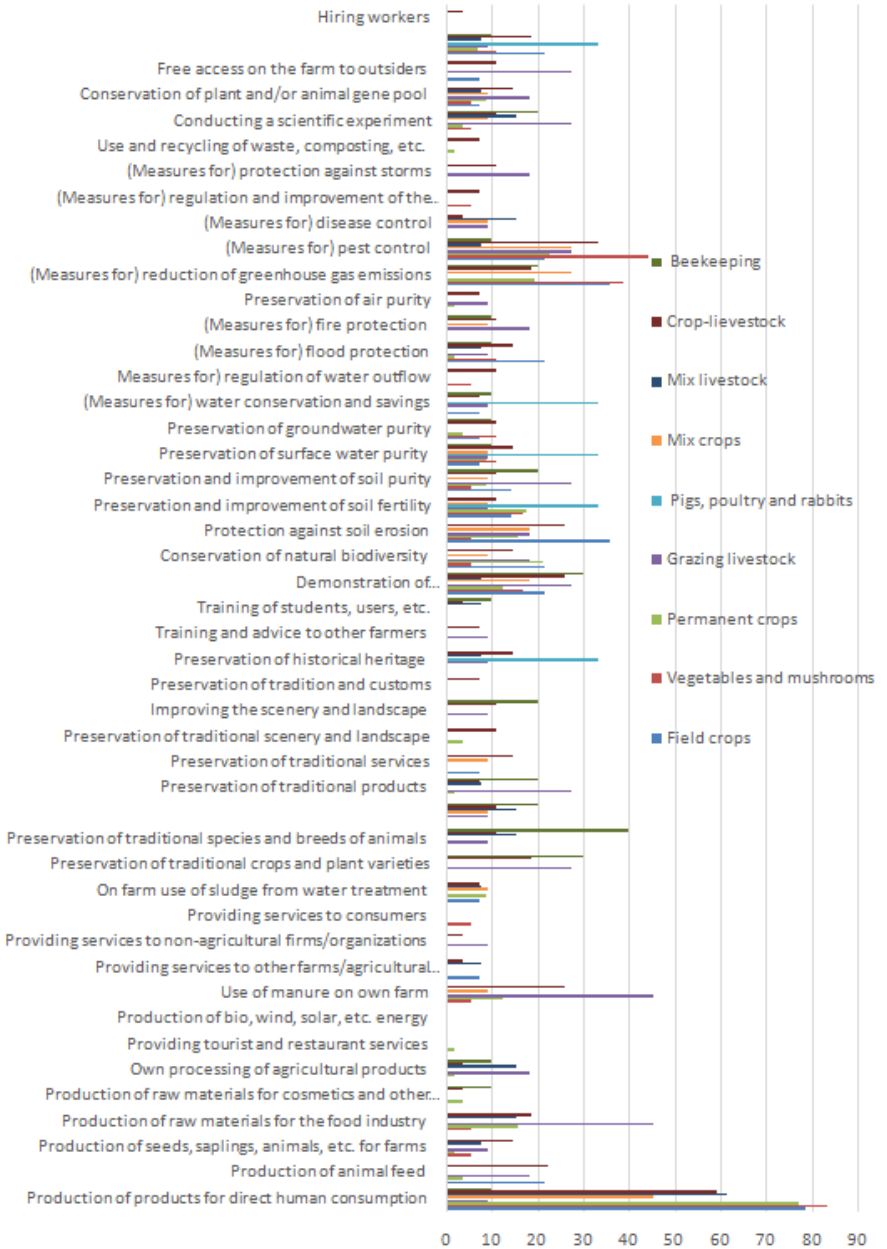

Figure 7. *Share of farms with different specialization participating (supporting) the preservation or production of different types of agro-ecosystem services in Bulgaria (%)*

Source: Survey of agricultural producers, 2020

Socio-economic and ecological importance of agroecosystem services

According to the majority of managers of the surveyed farms, their activities for the protection of ecosystems and their services areassociated with an Increasing the economic efficiency of the farm, Increasing the ecological efficiency of the farm, Increasing the social efficiency of the farm, Improved protection of ecosystems in the region, and Improved protection of ecosystems in the country. At the same time, the majority of farms estimate that their environmentally friendly activity leads to a *high* increase in the economic efficiency of the farm (59.09%), the ecological efficiency of the farm (55.22%) and the Protection of ecosystems in the region (47.54%).

None or very few of the surveyed farms indicate that their activities for the protection of ecosystems and their services are related to reducing the economic efficiency, environmental and social efficiency of the farm, and the protection of ecosystems in the region and the country. However, a significant share of farm managers believe that their efforts and costs to protect ecosystems and ecosystem services do not lead to changes in the social efficiency of the farm (36.17%) and improved protection of ecosystems in the country (37.78%).

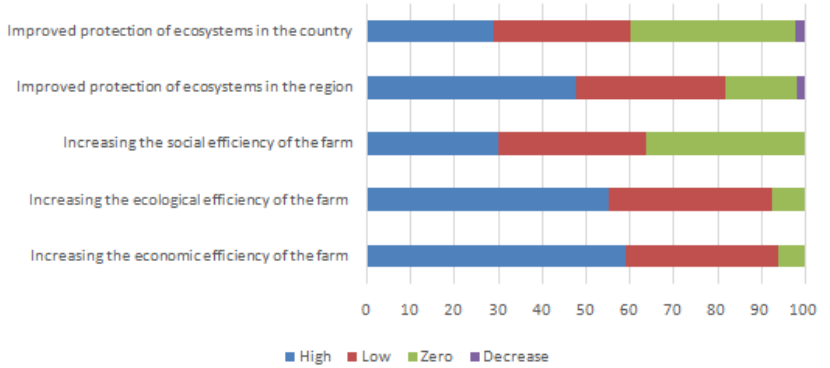

Figure 8. *Efficiency of the farms' activity for protection of ecosystems and their services in Bulgaria (percentages)*
Source: Survey of agricultural producers, 2020

There is a significant differentiation in the level of efficiency of farm activities related to the protection of ecosystems and ecosystem services (Figure 9).

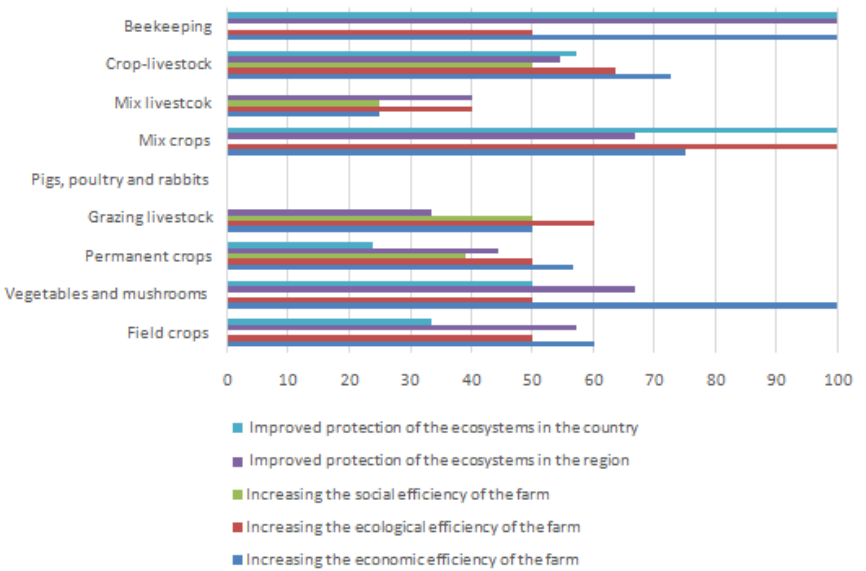

Figure9. *Share of farms with a high efficiency of activity for protection of ecosystems and their services in Bulgaria (percentages)*
Source: Survey of agricultural producers, 2020

High increase of the economic efficiency of the farm related to the protection of ecosystems and ecosystem services is most noted in the farms specialized in Field crops (60%), Vegetables and mushrooms (100%), Mixed crop production (75%), Mix crop-livestock production(72.73%) and Bee families (100%), and the least in those in Mixed livestock (25%) and Pigs, poultry and rabbits (0).

High increase of the ecological efficiency of the holdings' activity for protection of ecosystems and ecosystem services is reported by all from Mixed crops farms, and the majority of those with Grazing animals (60%) and Crop and animal husbandry (63.64%). The lowest share of farms with similar growth is in those specialized in Mixed Livestock (40%) and Pigs, poultry and rabbits (0).

High Increasing the social efficiency of the holdings's activity for protection of ecosystems and ecosystem services is registered by every second farm specializing in Herbivores and Corp-livestock, a smaller part of those in Perennial crops (39.13%) and Mixed livestock (25 %), and from none of the other categories of holdings.

High improved protection of ecosystems in the region, related to the activity of farms for protection of ecosystems and ecosystem services is achieved mostly by the farms in Field crops (57.14%), Vegetables and mushrooms (66.67%), Mixed crop growing (66.67%), and Bee families (100%), and relatively the least of those with Grazing animals (33.33%) and Pigs, poultry and rabbits (0).

High improved protection of ecosystems in the country related to the activities of farms for protection of ecosystems and ecosystem services is reported by all those specializing in Mixed crops and Bee families, and most of those in Mix crop-animal husbandry (57.14%). The share of farms with a similar effect is the lowest in those specialized in field crops (33.33%) and perennials (23.81%), and in none of them in

grazing animals, pigs, puultey and rabbits, and mixed animal husbandry.

The vast majority of farm managers estimate that the effect of the overall activity of the farm is positive in terms of soils (73.95%), biodiversity (62.3%), landscape (51.11%) and economic development of the region (60.82%). Also, the majority of managers believe that the effect is positive in terms of Air (48.54%), Surfacewaters (36.2%), Groundwaters (47.47%), Climate (38.37%), Traditional breeds, varieties, products, technologies. (44.68%), and Social development of the region (48.89%), as a relatively smaller part consider a positive effect in terms of Local culture, traditions, customs, education (28.39%).

However, the share of managers who believe that the whole activity of their farm is not associated eith any effect on the individual elements of the ecosystem - Soils (14.29%), Air (29.13%), Surfacewaters (34%), Groundwaters (26.26%), Biodiversity (16%), Landscape (17.78%), Climate (23.26%), Traditional breeds, varieties, products, technologies (20.21%), Local culture, traditions, customs, education (32.1%), Economic development of the region (16.49%) and Social development of the region (18.89%).

In addition, a significant part of managers do not know the effect of the overall activity of agriculture on various elements of the ecosystem - Soils (10.92%), Air (20.39%), Surfacewaters (28.7%), Groundwaters (26.26%), Biodiversity (21.7%), Landscape (30%), Climate (34.88%), Traditional breeds, varieties, products, technologies (31.91%), Local culture, traditions, customs, educated (37.04%), Economic development of the region (19.59%), and Social development of the region (27.78%). The later requires both deepening and expanding independent assessments of the effects of farming on the individual components of ecosystems, and better informing farmers about their negative and /or positive

contribution to environmental protection and ecosystem services.

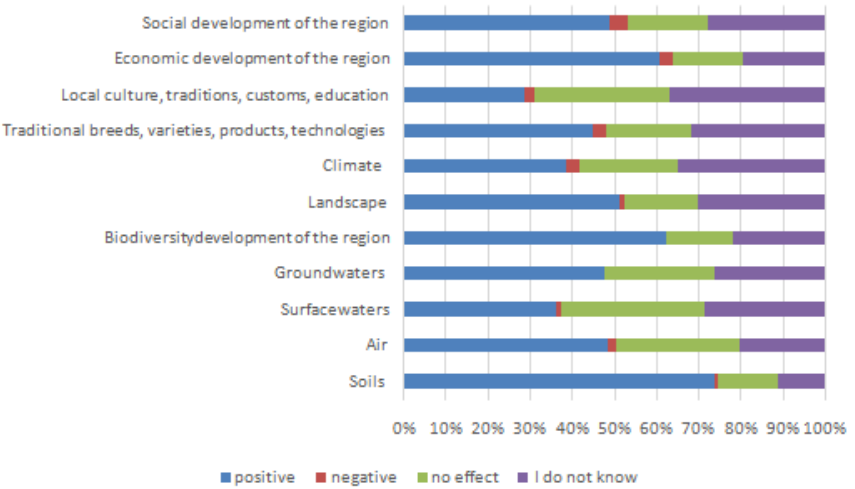

Figure 10. *Effect of the overall activity of the agricultural holdingon the different elements of the ecosystem in Bulgaria*
Source: Survey of agricultural producers, 2020

Just over half of the surveyed managers assess the importance of their activities for the protection of agro-ecosystems and agro-ecosystem services as High for their farm (50.62%) and 46.91% High for themselves (Figure 10). A significant share of managers also believe that their activities for the protection of agro-ecosystems and agro-ecosystem services are of high importance for the region of their farm (27.16%). There is also a significant number of managers who believe that this activity has a high environmental value (14.81%) and value for future generations (13.58%). A relatively smaller part of the managers believe that such activity is of High importance for the community in the region (7.41%), High market value (5.56%) and High economic value (6.17%).

At the same time, an insignificant share of managers are convinced that their activity for protection of agro-ecosystems and agro-ecosystem services has a High contract value (1.23%), and a High social value (2.47%) or is Without any value (1.23%), as none of the respondents believes that this activity has a High cultural value.

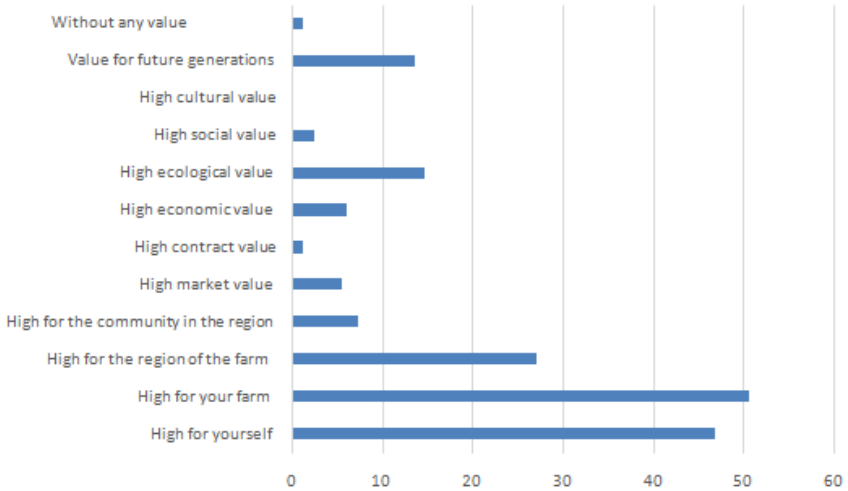

Figure 11. *Assessment of farm managers of the importance of their activity for protection of agro-ecosystems and agro-ecosystem services in Bulgaria (percentages)*

Source: Survey of agricultural producers, 2020

Conclusion

It is well known that agricultural production makes a significant contribution to the conservation, restoration and enhancement of ecosystems and their services, but also is associated with negative effect and their degradation and demolition („agricultural disservices"). Therefore, services related to agricultural production and agro-ecosystems are among the most intensively studied, mapped, evaluated, regulated and stimulated.

Our study has tried to fill the gap and give initial insighst on great variety of agricultural services and ther importance for the farm, region, other ecosystems and agents in Bulgaria. It found out that there are significant differences in the participation and contribution of agricultural holdings in the protection and provision of agro-ecosystem services in the variouse specific and principled ecosystems of the country, and major subsectors of agricultural production.The later requires special measures to improve, diversify and intensify this activity of farmers through training, information, exchange of experience, public incentives and support, etc.

Analyzes of the structure and importance of agro-ecosystem services in the country are to be expanded by improving the accuracy and representativeness of the information by increasing the number of surveyed farms, avoiding "douple" accounting, applying statistical methods to verify reliability, special "training" of and those involved in surveys, applying direct field measurmentsa experts and stakeholders involvments etc. This requires closer cooperation with agricultural producers'organizations, agricultural advisory and extension system, and all stakeholders, as well as improving the official system for collecting agricultural, agro-economic and agri-environmental data in the country.

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5 Unpacking competitiveness of agricultural farms in Bulgaria

Introduction

The problem of determining the competitiveness of various economic organizations is among the most topical academic and practical (aimed at improving business strategies and policies) issues from the emergence of economics science to the present day (Falciola & Rollo, 2020; Dresch *et al*., 2018; Westeren, *et al*., 2020; Wisenthige & Guoping, 2016). It is particularly important for the agricultural sector, which is characterized by many participants (including foreign ones), high specialization and exchange, strong competition at local, national and international level, and highly integrated food and supply chains. Moreover, this sector has a number of specifics such as the dominance of small property and informal management, the existence of quasi-monopoly situations in supply and sales, strong dependence on natural conditions, unequal public support, market segmentation, strong state

regulation, processing and trade chains, professional organizations, etc., strong consumer pressure for quality, eco-behavior, etc., presence of underdeveloped and non-competitive "markets", needs for new approaches, etc.

The problem of competitiveness has become particularly relevant in recent decades as a result of the fundamental development of the Theory of Economic Organizations (Bachev, 2012; Porter, 1980; Williamsom, 1996), the processes of globalization and competition and the new social and market "order" defined from international agreements and institutions (World Trade Organization, World Bank, International Monetary Fund, European Union, etc.) (EC; FAO; OECD). The latest processes such as the COVID-19 pandemic, climate change, fundamental reform and greening of the Common Agricultural Policy (CAP) of the European Union (EU), widespread digitalisation, etc. pose new challenges to the competitiveness of agricultural producers in the country and around the world.

Despite its importance and long-term lively discussions, there is still no consensus on: what is the competitiveness of agricultural holdings, how to measure the competitiveness of different organizations in agriculture, what is the absolute and comparative competitiveness of different types of agricultural farms, which are critical factors for increasing the competitiveness at the current stage of development, etc. Addressing all these issues is not just an important research issue, but a question of concern to farm managers and owners, professional and non-governmental organizations, politicians and the general public. It is no coincidence that increasing the viability and competitiveness of the sectors and agricultural producers has again been identified as one of the strategic objectives of the EU CAP in the new programming period 2021-2027. (EU, 2018).

Numerous studies have emerged in recent years on various aspects of the competitiveness of farms of different

(mostly small) sizes (Alam *et al.*, 2020; Berti & Mulligan, 2016; Latruffe, 2010, 2013; Lundy, *et al.*, 2010; Mmari, 2015; Ngenoh *et al.*, 2019; Orłowska, 2019), in selected countries (Alam *et al.*, 2020; Benson, 2007; Jansik & Irz, 2015; Hadley, 2006; Popovic, Knezevic & Tosin, 2009 ; Kleinhanss, 2020; Krisciukaitiene, Melnikiene, & Galnaityte, 2020; Nivievskyi, *et al.*, 2011; Nowak, 2016; Mykhailova *et al.*, 2018; Orłowska, 2019; Ziętara & Adamski, 2018), subsectors (Alam *et al.* , 2020; Benson, 2007; FAO, 2010; Jansik & Irz, 2015; Kleinhanss, 2020; Marques *et al.*, 2011; Marques, 2015; Nivievskyi, *et al.*, 2011; Ngenoh *et al.*, 2019; Oktariani, Daryanto, & Fahmi, 2016; Ziętara & Adamski, 2018), farming systems, such as organic, vertically integrated, greenhouse, etc. (Marques, 2015; Orłowska, 2019), regions (Marques *et al.*, 2011; Nowak, 2016) and chain producers (Lundy, *et al.*, 2010; Ngenoh *et al.*, 2019), comparative studies in different EU countries (FAO, 2010; Jansik and Irz, 2015; Nowak & Krukowski, 2019; Ziętara & Adamski, 2018), and technological, institutional and organizational factors for improving farm competitiveness (Berti & Mulligan, 2016; Mmari, 2015; Ngenoh *et al.*, 2019; Oktariani, Daryanto, & Fahmi, 2016; OECD, 2011), etc.

To date, however, there is no widely accepted and comprehensive framework for understanding and assessing the competitiveness of farms in different market, economic, institutional and natural environments. Usually the competitiveness of agricultural holdings is not well defined and is assessed through traditional indicators of technical efficiency, productivity, profitability, etc. Rarely is a systematic approach applied to the formulation of pillars and the principles of competitiveness, to the criteria and indicators of evaluation at its level, to the integration and interpretation of assessments, etc. Moreover, important aspects of farm competitiveness such as management efficiency, potential and incentives for adaptation, and 'long-

term' sustainability are often completely ignored in the analyzes.

In Bulgaria, modern research on the absolute and comparative competitiveness of agricultural holdings is at the beginning stage (Andonov, 2013; Alexiev, 2012; Borisov, 2007; Bashev, 2010, 2011, 2017; Ivanov *et al.*, 2020; Koteva & Bashev, 2010, 2021; Koteva, 2016; Koteva *et al.*, 2018; Slavova *et al.*, 2011; Bachev, 2010). The number of publications on the level of competitiveness of agricultural holdings at the stage of EU CAP implementation is insignificant. In addition, there are practically no comprehensive studies on the competitiveness of farms with different product specialization at the current stage of development of the sector. This deters both for farms management and the improvement of public support policies for farmers of different kinds.

This study tries to fill the existing gap by applying a holistic approach and assessing the competitiveness of farms as a whole and with different specializations in Bulgaria.

Research methodology

Competitiveness means the capability (internal ability, potential, incentives) of the agricultural holding to maintain sustainable competitive positions on (certain) market(s), leading to high economic performance through continuous improvement and adaptation to changing market, natural and institutional environment (Bachev, 2010; Koteva & Bachev, 2010). The level of competitiveness is always specific to a particular market-oriented farm in relation to the markets in which it sells its products and services.

Efficiency, financial emdowment, adaptability and sustainabilityare the main "pillars" of the competitiveness of agricultural holdings. Good competitiveness means that a farm (1) produces and sells its products and services efficiently on the market, (2) manages its financing efficiently

(3) is adaptable to the evolving market, institutional and natural environment, and (4) is sustainable in time (Bachev, 2010; Koteva & Bashev, 2010). Conversely, insufficient (lack of) competitiveness indicates that the farm has serious problems in efficient financing, production and sale of products due to high production and/or transaction costs, inability to adapt to evolving environmental conditions and/or insufficient sustainability over time.

For assessing the particular and integral level of competitiveness of Bulgarian farms, a holistic approach is applied, which includes a system of 4 criteria and 17 indicators and reference values, taking into account economic efficiency, financial capabilities, adaptation potential and the level of sustainability of farms (Table 1). The choice of appropriate reference values is particularly important for an adequate assessment of the level of competitiveness. For example, a significant overpassing of the sectoral productivity and profitability is a sign of (higher) efficiency and competitiveness of farms; lack of "sufficient" liquidity - for small financial capability and low (non)competitiveness; the serious problems of marketing the production and the lack of an heir willing to take over the farm - for low sustainability and competitiveness, etc.

Table 1. *Criteia and Indicators for Assessing Competitivness of Bulgarian Farms*

Criteria	Indicators	
	Particular	Integral
Economic efficiency	Labor productivity	Index of Economic Efficiency
	Land and livestock productivity	
	Income per utilized of land and livestock	
	Profitability of farm	
Financial endowment	Profitability of own capital	Index ofFinancial Endowment
	Liquidity	
	Level of Financial autonomy	
Adaptability	Level of Adaptability to	Index ofAdaptability

	natural environment	
	Level of Adaptability to market environment	
	Level of Adaptability to institutional environment	
Sustainability	Level of Sustainability in supply of land and natural resources	Index of Sustainability
	Level of sustainability in supply of labor	
	Level of Sustainability in inputs supply	
	Level of Sustainability in supply with innovation and know-how	
	Level of Sustainability in funding	
	Level of Sustainability in supply with services	
	Level of Sustainability in utilization and marketing of produce s and services	
		Index of Competitivness

Source: author

A detailed presentation of the applied holistic approach, and the criteria for selection and integration of indicators for assessing the competitiveness of farms in Bulgaria is presented by Bachev (2010) and Koteva & Bachev (2010; 2021).

There is a lack of adequate (statistical and other) information in the country for assessing the various aspects of competitiveness of agricultural farms. In this study, the assessment of the level of competitiveness of farms is based on primary (survey) micro information provided in the summer of 2020 by the managers of 319 "typical" farms[1] of different types, production specializations and geographical locations. The structure of the surveyed farms approximately

[1] The authors are grateful to the National Agricultural Advisory Service for their assistance and to all managers of the surveyed farms - for the information provided.

corresponds to the real structure of the farms in the country and in the main sub-sectors of the agricultural production in Bulgaria.

A summary of the surveyed holdings and their managers (owners) is presented in Table 2 and Table 3.

Farm managers are given the opportunity to indicate one of the three levels (low, good, high), which most closely corresponds to the condition of their holding for each indicator of the four competitiveness criteria. The qualitative assessments of the managers were transformed into quantitative values, as the high levels were assessed with 1, the intermediate with 0.5, and the low with 0.

For each of the agricultural holdings, an integral competitiveness index is calculated for the individual criteria and as a whole, as an arithmetic avarages. The competitiveness indices of farms with different types of specialization were obtained as arithmetic avarage from the individual indices of the constituent holdings. To determine the overall level of competitiveness, the following banchmarks were used, set up by leading experts in the field: high level 0.51-1, good level 0.34-0.5 and low level 0-0.32.

Table 2. *General characteristics of surveyed agricultural holdings in Bulgaria*

Characteristic	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing livestock	Pigs, poultry and rabbits	Mix crops	Mix livestock	Mix crop-livestcok	Beekeeping	Share in total
Physical person	73.91	96.67	97.40	93.75	100.00	93.33	100.00	94.55	88.89	94.30
Sole trader	8.70	3.33	0.00	3.13	0.00	4.44	0.00	1.82	0.00	2.22
Cooperative	8.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63
Company	8.70	0.00	2.60	3.13	0.00	0.00	0.00	1.82	11.11	2.22
Association	0.00	0.00	0.00	0.00	0.00	2.22	0.00	1.82	0.00	0.63
Mostly for self-sufficiency	8.33	3.33	5.33	9.68	6.67	6.98	11.76	5.66	11.11	6.49
Small for the sector	41.67	70.00	66.67	67.74	93.33	62.79	29.41	66.04	22.22	61.69
Averagefor the sector	45.83	26.67	26.67	22.58	0.00	27.91	58.82	26.42	55.56	29.87
Big for the sector	4.17	0.00	1.33	0.00	0.00	2.33	0.00	1.89	11.11	1.95

Plain region	75.00	83.33	60.26	50.00	56.25	46.67	44.44	55.36	44.44	58.31
Mountain and semi-mountain region	12.50	6.67	25.64	28.13	25.00	26.67	27.78	21.43	11.11	21.94
With lands in protected areas and territories	0.00	3.33	6.41	12.50	6.25	6.67	11.11	12.50	22.22	7.84
Mountain region with natural restrictions	20.83	3.33	12.82	15.63	18.75	22.22	16.67	26.79	33.33	18.18
Non-mountainous regio with natural restrictions	0.00	6.67	3.85	12.50	0.00	8.89	11.11	5.36	11.11	5.96
Share in total	7.55	12.58	24.53	10.06	5.03	14.15	5.66	17.61	2.83	319

Source: Survey with agricultural producers, 2020

Table 3. *General characteristics of surveyed managers of agricultural holdings in Bulgaria*

Characteristic	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing ivestock	Pigs, poultry and rabbits	Mix crops	Mix ivestock	Mix crop-livestcok	Beekeeping	Share in total
Man	62.50	39.29	59.46	68.75	53.33	53.04	72.22	50	78.18	62.62
Woman	29.17	60.71	39.19	31.25	46.67	28.26	22.22	40.00	21.82	34.50
Partnership	0.00	0.00	1.35	0.00	0.00	8.70	5.56	10.00	0.00	2.24
Group property	8.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64
Young farmer (up to 40 years)	0.00	66.67	57.97	55.56	53.33	35.90	53.33	50.00	31.48	46.26
Age from 41 to 55 years	56.25	18.52	23.19	33.33	33.33	48.72	20.00	25.00	46.30	34.52
Age from 56 to 65 years	37.50	11.11	10.14	3.70	6.67	12.82	26.67	25.00	18.52	13.88
Over 65 years	6.25	3.70	8.70	7.41	6.67	2.56	0.00	0.00	3.70	5.34
Basic education	16.67	0.00	6.41	18.75	0.00	6.67	16.67	0	7.14	7.86
Secondary agricultural	4.17	13.79	6.41	3.13	6.25	15.56	0.00	0.00	1.79	6.60
Secondary comprehensive	41.67	48.28	42.31	59.38	62.50	46.67	27.78	11.11	58.93	48.43
Univercity agricultural	16.67	13.79	11.54	9.38	6.25	4.44	11.11	11.11	7.14	9.75
Another univercity	20.83	24.14	33.33	9.38	25.00	26.67	44.44	77.78	25.00	27.36
Professional agricultural qualification	0.00	0.00	0.00	3.13	0.00	0.00	0.00	0.00	1.79	0.63

Source: Survey with agricultural producers, 2020

Overall level of competitiveness of Bulgarian farms

The multi-criteria assessment of the competitiveness of agricultural holdings in the country shows that it is at a *good level* with a competitiveness index of 0.4 (Figure 1). The relatively high *sustainability* of farms (index 0.49) and, to a

lesser extent, their good *financial security* (index 0.41) contribute the most to maintaining this level of competitiveness. On the other hand, the *adaptability* of agricultural holdings is relatively lower (index 0.39) and their *economic efficiency* is low (index 0.29). Therefore, the low potential for adaptation and the unsatisfactory economic efficiency contribute to the greatest extent to the decreasing of the competitiveness of the Bulgarian farms, as they are critical for the maintenance and restrict the increase of its level.

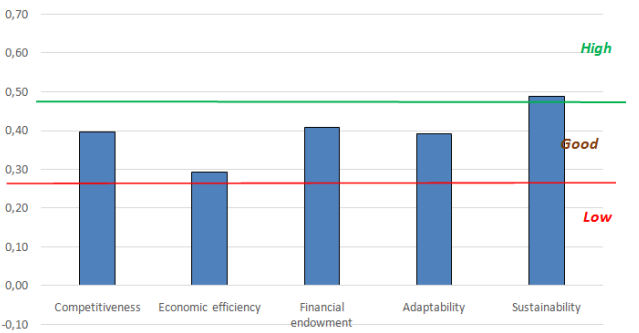

Figure 1. *Level of competitiveness of agricultural holdings in Bulgaria*
Source: Author's calculations

The analysis of the individual indicators of competitiveness shows the factors that most contribute to or limit the competitiveness of agricultural holdings in the country. At the present stage, the increase in the competitiveness of farms is limited by their extremely low *productivity* (0.16), *profitability* (0.19), *financial capability* (0.31) and *adaptability* to changes in the natural environment (warming, extreme weather, droughts, storms, etc.) - 0.33 (Figure 2). Both public support for farms and their management development strategies should be focused on these areas that are critical to competitiveness.

On the other hand, a number of indicators for the competitiveness of farms are at a high level and show the comparative and absolute competitive advantages of country's farms. To the greatest extent to increasing the competitiveness of agricultural holdings at the present stage contribute the *lack of serious problems and difficulties in the efficient supply of necessary services* (0.56), *efficient supply of land and natural resources* (0.55), *efficient supply of materials, equipment and biological resources* (0.51) and *low dependence on external financing* (credit, state aid, etc.) or *high financial autonomy* (0.52).

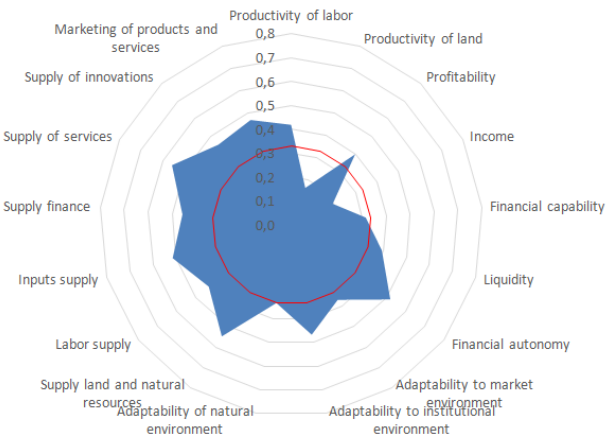

Figure 2. *Indicators for competitiveness of agricultural holdings in Bulgaria*
Source: Author's calculations

The assessment of the competitiveness of agricultural holdings shows that the majority of them (47.65%) are with a good competitiveness (Figure 3). Slightly more than half of the Bulgarian farms (50.47%) have a level of competitiveness above the national average (Figure 4), and only 17.55% of all farms in the country have a high level of competitiveness.

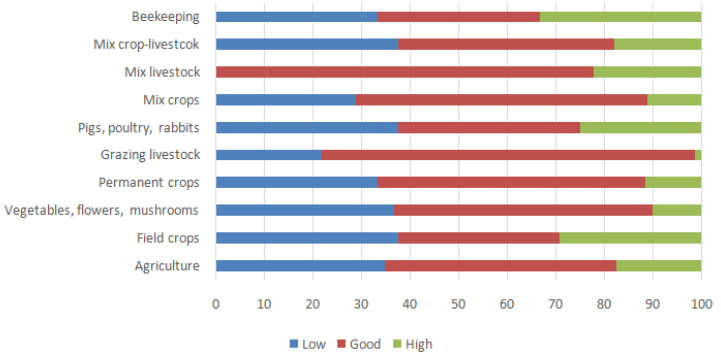

Figure 3. *Share of agricultural holdings with different level of competitiveness in Bulgaria(%)*
Source: Author's calculations

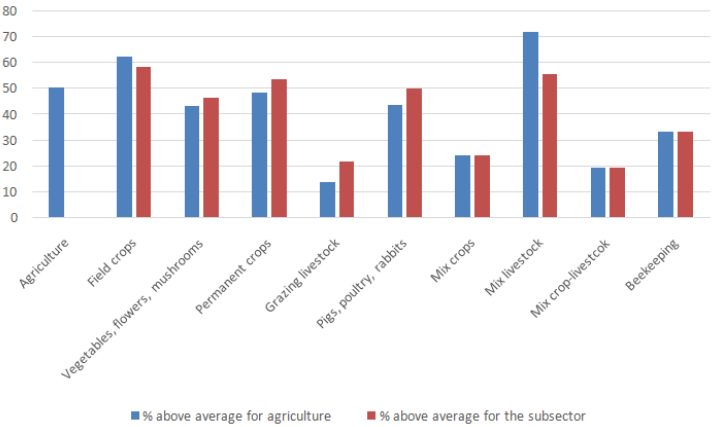

Figure 4. *Share of agricultural holdings with a level of competitiveness above the national average and the sub-sector in Bulgaria*
Source: Author's calculations

At the same time, however, more than a third of all farms (34.8%) have a low level of competitiveness. This means that a large part of Bulgarian farms will cease to exist in the near future due to insufficient competitiveness if timely measures are not taken to increase competitiveness by improving the management and restructuring of farms, adequate state support, etc.

The vast majority of managers surveyed (64%) rated the competitiveness of their farms as good (Figure 5). The self-assessment of a large part of the managers differs from the multicriteria assessment made in the study, as the deviations are in both directions. Every tenth manager underestimates the (higher) level of competitiveness of their farm, and about 5% overestimate it. This means that independent multi-criteria assessments of competitiveness for the real situation would raise awareness and improve the management of a significant part of the country's farms.

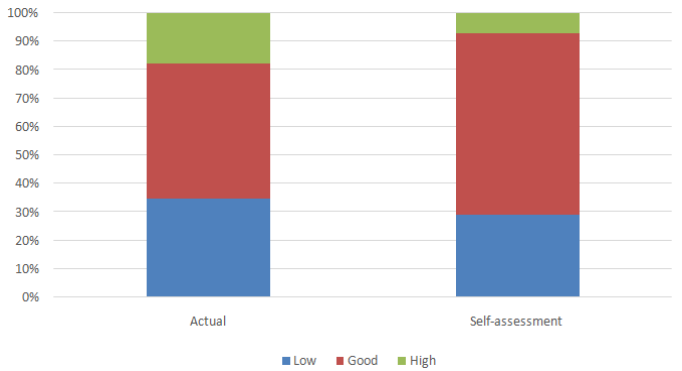

Figure 5. *Comparison of the multicriteria assessment with the self-assessment of the managers for the competitiveness of the agricultural holdings in Bulgaria*
Source: Author's calculations, Survey with agricultural producers, 2020

The analysis of the share of farms with different levels of competitiveness indicators gives a clear idea of the situation in the country. The majority of Bulgarian farms have productivity and profitability, well below the national average - 68.54% and 62.79%, respectively (Table 3). Also, a significant part of the farms have low financial capability (38.02%), high dependence on external financing (loan, subsidies, etc.) (23.95%) and low ability to pay their current liabilities (26.58%) (Table 4).

In addition, 31.65% of country's farms have low adaptability to changes in the market environment (demand, prices, competition, etc.), 18.99% have insufficient adaptability to the institutional environment and constraints (national and European requirements for quality, safety, environment, etc.), and 36.39% have a low ability to adapt to changes in the natural environment (warming, extreme weather, drought, storms, etc.) (Table 5).

According to the managers of a large part of the farms in the country (15.71%), their farms have low sustainability in the medium term and are likely to cease to exist due to bankruptcy, cessation of business, acquisition by competitors, etc. (Figure 6).

The survey also found that a significant part of the farms in the country have serious problems with the effective provision of the necessary labor force (30.5%), the necessary financing (20.89%), the necessary innovations and know-how (27.30%) and the effective marketing of production and services (18.85%) (Table 6). In addition, for every tenth farm there are major problems in the efficient supply of the necessary materials, equipment and biological resources (10.13%), for every ninth - in the effective supply of the necessary land and natural resources (8.68%), and for every seventh - in the effective supply of the necessary services (7.30%). All this contributes significantly to reducing the sustainability and competitiveness of a significant part of the holdings in the country.

The vast majority of managers (77.88%) evaluate the sustainability of their farms as good (Figure 7). In contrast to competitiveness, in the self-assessments for sustainability, there is almost a coincidence of the share of farms with low sustainability with that of the multi-criteria assessment in the study. However, there is a significant underestimation of the level of "real" sustainability in the self-assessment of managers of farms with high sustainability - a little over 5

times. This means that many farm managers do not have an accurate idea of the real level of (economic) sustainability of the farms they manage. Therefore, holistic "external" sustainability assessments, such as in this study, would greatly improve the awareness, self-confidence and overall management of a significant part of the country's farms.

Table 3. *Share of agricultural holdings with different level of indicators for economic efficiency in Bulgaria (percentage)*

Indicators levels	Agriculture	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing livestock	Pigs, poultry and rabbits	Mix crops	Mix livestock	Mix crop-livestcok	Beekeeping
Productivity										
Low	22.40	12.50	13.79	30.77	28.13	31.25	18.18	11.11	23.21	33.33
Good	71.92	70.83	82.76	61.54	71.88	62.50	81.82	83.33	75.00	44.44
High	5.68	16.67	3.45	7.69	0.00	6.25	0.00	5.56	1.79	22.22
Profitability										
Unsatisfactory	25.55	16.67	17.24	32.05	31.25	25.00	22.73	16.67	28.57	44.44
Good	69.40	70.83	79.31	61.54	68.75	75.00	75.00	77.78	69.64	33.33
High	5.05	12.50	3.45	6.41	0.00	0.00	2.27	5.56	1.79	22.22
*Gross output**										
Similar to the avarage	10.93	16.67	10.71	9.86	3.13	0.00	20.45	6.67	3.57	28.57
A little more than the avarage	3.64	12.50	3.57	4.23	3.13	0.00	0.00	0.00	5.36	0.00
A lot more than the avarage	1.32	0.00	0.00	1.41	0.00	0.00	2.27	0.00	3.57	0.00
A little less than the avarage	15.56	25.00	7.14	11.27	12.50	6.67	22.73	26.67	17.86	0.00
A lot less than the avarage	68.54	45.83	78.57	73.24	81.25	93.33	54.55	66.67	69.64	71.43
Net Income**										
Similar to the avarage	10.63	16.67	10.71	9.72	0.00	0.00	20.93	0.00	5.36	28.57
A little more than the avarage	4.65	12.50	3.57	6.94	3.23	0.00	0.00	6.67	5.36	0.00
A lot more than the avarage	1.66	0.00	0.00	2.78	0.00	0.00	2.33	0.00	3.57	0.00
A little less than the avarage	20.27	29.17	3.57	15.28	16.13	20.00	30.23	33.33	17.86	14.29
A lot less than the avarage	62.79	41.67	82.14	65.28	80.65	80.00	46.51	60.00	67.86	57.14

Note: ** Avarage for the country Gross output = 133200 BGL; ** Avarage for the country Net Income = 38000 BGL*

Source: Survey with agricultural producers, 2020

Table 4. *Share of agricultural holdings with different level of indicators for financial endowment in Bulgaria (percentage)*

Agriculture	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing livestock	Pigs, poultry and rabbits	Mix crops	Mix livestock	Mix crop-livestc
Financial capability								
38.02	26.09	46.43	40.26	51.61	50.00	28.89	22.22	39.29
61.34	73.91	53.57	59.74	48.39	50.00	71.11	77.78	58.93
0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79
Dependaance from external financing (credit, state support, etc.)								
27.83	30.43	28.57	28.38	28.13	26.67	25.58	16.67	30.36
48.22	52.17	46.43	50.00	40.63	46.67	46.51	55.56	44.64
23.95	17.39	25.00	21.62	31.25	26.67	27.91	27.78	25.00
Possibility to pay current debts								
26.58	25.00	31.03	24.68	43.75	33.33	15.56	22.22	32.14
68.04	66.67	65.52	71.43	56.25	66.67	73.33	72.22	66.07
5.38	8.33	3.45	3.90	0.00	0.00	11.11	5.56	1.79

Source: Survey with agricultural producers, 2020

Table 5. *Share of agricultural holdings with different levels of indicators for adaptability in Bulgaria (percentage)*

rs	Agriculture	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing livestock	Pigs, poultry and rabbits	Mix crops	Mix livestock	Mix crop-livestcok	B
ty to the market (prices, demand, competition)										
	31.65	25.00	17.24	37.66	50.00	25.00	24.44	33.33	33.93	
	62.66	62.50	72.41	59.74	46.88	62.50	73.33	61.11	64.29	
	5.70	8.33	10.34	3.90	3.13	12.50	2.22	5.56	0.00	
ty to the state and European requirements for quality, safety, environment, etc.										
	18.99	20.83	20.69	11.69	34.38	18.75	20.00	16.67	23.21	
	68.35	66.67	72.41	77.92	65.63	62.50	64.44	50.00	66.07	
	12.66	12.50	6.90	10.39	0.00	18.75	15.56	33.33	8.93	
ty to changes in the natural environment (warming, extreme weather, drought, storms, etc.)										
	36.39	29.17	34.48	41.56	34.38	37.50	33.33	22.22	46.43	
	60.44	66.67	65.52	55.84	59.38	62.50	64.44	61.11	51.79	
	3.16	0.00	0.00	3.90	0.00	0.00	2.22	16.67	3.57	

Source: Survey with agricultural producers, 2020

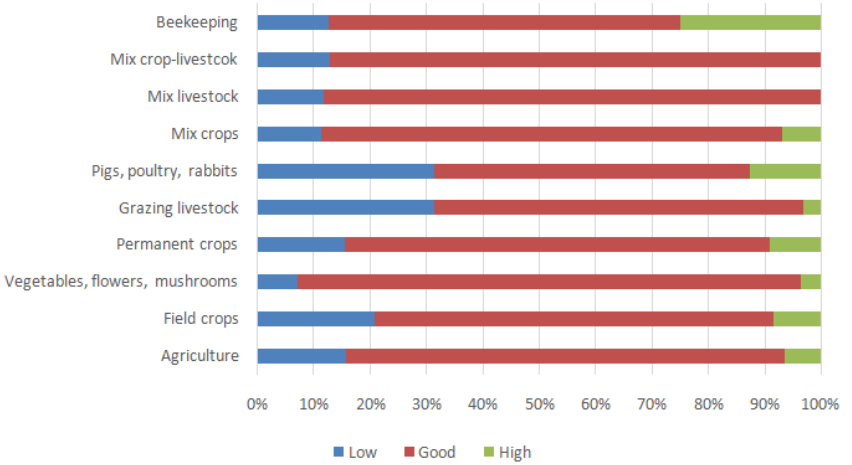

Figure 6. *How do you assess the sustainability of agricultural holding in the medium term?*
Source: Survey with agricultural producers, 2020

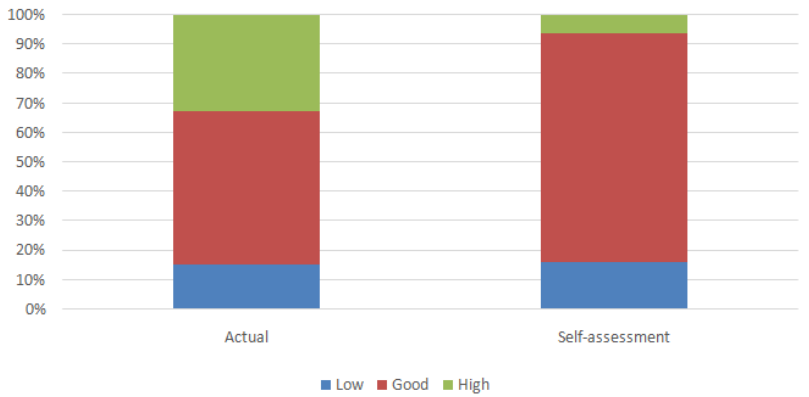

Figure 7. *Comparison of the multicriteria assessment with the self-assessment of the managers for the sustainability of the agricultural holdings in Bulgaria*
Source: Author's calculations, Survey with agricultural producers, 2020

Table 6. *Share of agricultural holdings with different levels of indicators for sustainability in Bulgaria (percentage)*

Indicators type	Agriculture	Field crops	Vegetables, flowers and mushrooms	Permanent crops	Grazing livestock	Pigs, poultry and rabbits	Mix crops	Mix livestock	Mix crop-livestcok	Beekeeping
Nature of the problems in effective supply of necessary land and natural resources										
Insignificant	18.65	20.83	22.22	14.29	18.75	40.00	20.45	11.11	14.55	50.00
Normal	72.67	75.00	77.78	75.32	62.50	53.33	72.73	72.22	78.18	37.50
Significant	8.68	4.17	0.00	10.39	18.75	6.67	6.82	16.67	7.27	12.50
Nature of the problems in effective supply of necessary labor force										
Insignificant	16.67	16.67	27.59	10.26	18.75	18.75	8.89	5.56	25.00	44.44
Normal	52.83	66.67	51.72	53.85	40.63	68.75	53.33	50.00	50.00	33.33
Significant	30.50	16.67	20.69	35.90	40.63	12.50	37.78	44.44	25.00	22.22
Nature of the problems in effective supply of necessary materials, equipment and biological resources										
Insignificant	12.97	12.50	24.14	10.53	9.38	6.25	13.33	11.11	12.50	33.33
Normal	76.90	79.17	65.52	75.00	78.13	81.25	82.22	77.78	76.79	66.67
Significant	10.13	8.33	10.34	14.47	12.50	12.50	4.44	11.11	10.71	0.00
Nature of the problems in effectivesupply of necessary funding										
Insignificant	12.03	4.17	10.34	15.58	9.68	0.00	13.33	16.67	14.29	22.22
Normal	67.09	83.33	58.62	70.13	54.84	87.50	57.78	72.22	62.50	77.78
Significant	20.89	12.50	31.03	14.29	35.48	12.50	28.89	11.11	23.21	0.00
Nature of the problems in effective supply of necessary services										
Insignificant	18.41	8.33	27.59	21.05	15.63	25.00	15.56	16.67	19.64	22.22
Normal	74.29	79.17	72.41	71.05	75.00	62.50	80.00	72.22	73.21	77.78
Significant	7.30	12.50	0.00	7.89	9.38	12.50	4.44	11.11	7.14	0.00
Nature of the problems in effective supply of necessary innovations and know-how										
Insignificant	17.46	16.67	14.29	21.79	18.75	18.75	17.78	23.53	12.50	11.11
Normal	55.24	58.33	57.14	61.54	37.50	50.00	53.33	52.94	55.36	88.89
Significant	27.30	25.00	28.57	16.67	43.75	31.25	28.89	23.53	32.14	0.00
Nature of the problems in effective realization of the products and services										
Insignificant	12.46	20.83	17.86	14.29	6.45	12.50	11.11	5.56	10.71	12.50
Normal	68.69	66.67	71.43	63.64	67.74	62.50	75.56	83.33	67.86	62.50
Significant	18.85	12.50	10.71	22.08	25.81	25.00	13.33	11.11	21.43	25.00

Source: Survey with agricultural producers, 2020

Level of competitiveness of farms with different specialization

There is a significant variation in the level of competitiveness of agricultural holdings with different production specializations (Figure 8). The farms with the highest *good* competitiveness are in the bee sector (0.46), followed by those specialed in field crops (0.44), mixed livestock (0.42), and mixed crop production (0.41).

Farms in a number of major agricultural sub-sectors are with a good competitiveness, but below the national average – permanent crops (0.39), vegetables, flowers and

mushrooms (0.38), pigs, poultry and rabbits (0.38) and mixed crop-livestock (0.38) .

The weakest is the competitiveness of farms specializing in grazing livestock , which is at a *low* level (0.32).

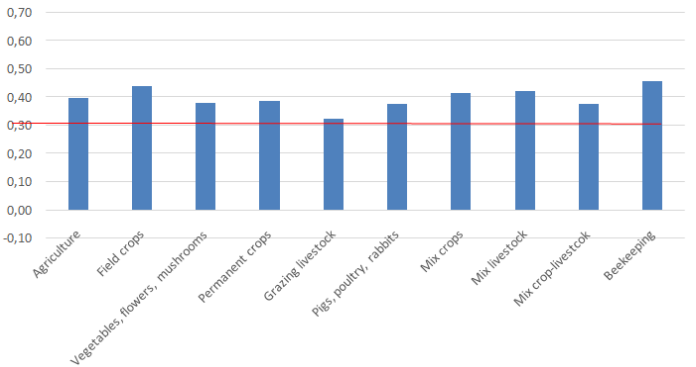

Figure 8. *Competitiveness of agricultural holdings with different specialization in Bulgaria*
Source: Author's calculations

The analysis of the individual aspects of the competitiveness of farms with different specializations shows that most types have low economic efficiency and it contributes the most to the deterioration of their competitiveness (Figure 9). Only farms specializing in field crops have good economic efficiency.

The farms with specialization in beekeeping (0.48) have the best financial endowment, followed by field crops (0.45) and mixed crop farms (0.44). The financial endowment of farms specialized in mixed crop and livestock production (0.4), vegetables, flowers and mushrooms (0.38), pigs, poultry and rabbits (0.36) and grazing animals (0.34) is below the national average, the latter group being close to the low level.

The farms with specialization in beekeeping (0.54), mixed animal husbandry (0.47) and pigs, poultry and rabbits (0.42) have the highest adaptability. The potential for adaptation to

changes in the market, institutional and natural environment in farms specializing in permanent crops (0.38) and mixed crop and livestock (0.35) is below the industry average, and in farms with grazing animals - at a low level (0.3).

The sustainability of most types of farms is relatively good and close to the national average. With the lowest sustainability, within the limits of the good level, are the farms specialized in the grazing livestock (0.44). The sustainability of the other groups of farms is at a high level, with maximum value for those specialized in beekeeping.

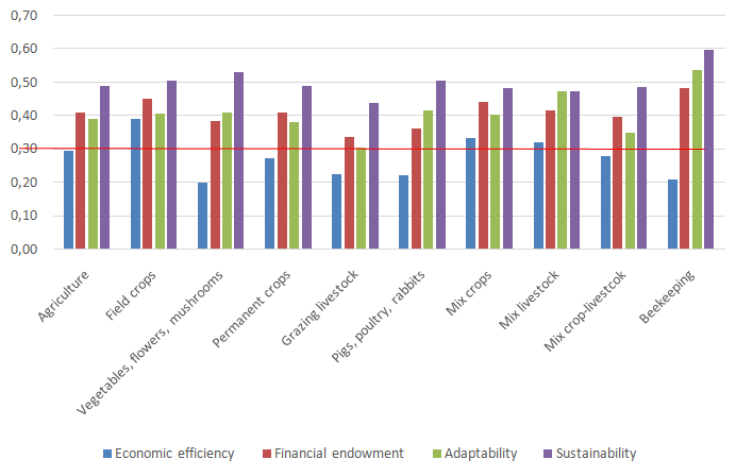

Figure 9. *Level of competitiveness of agricultural holdings with different specialization by main criteria for competitiveness in Bulgaria*
Source: Author's calculations

Most of the indicators of competitiveness of farms specializing in *field crops* have values higher than the national average (Figure 10). Only in terms of adaptability to the institutional environment and efficiency of service provision, these farms have lower than average levels.

The competitiveness of farms specializing in the cultivation of field crops is maintained by high productivity,

liquidity, financial autonomy, adaptability to the market environment, efficiency in the supply of land and natural resources, materials, machinery and biological resources, finance, services and innovation, and efficient realization of products and services. The main factors for reducing the competitiveness of farms with field crops are low productivity (0.27) and profitability (0.29), as well as close to the low level, adaptability to the natural environment (0.35).

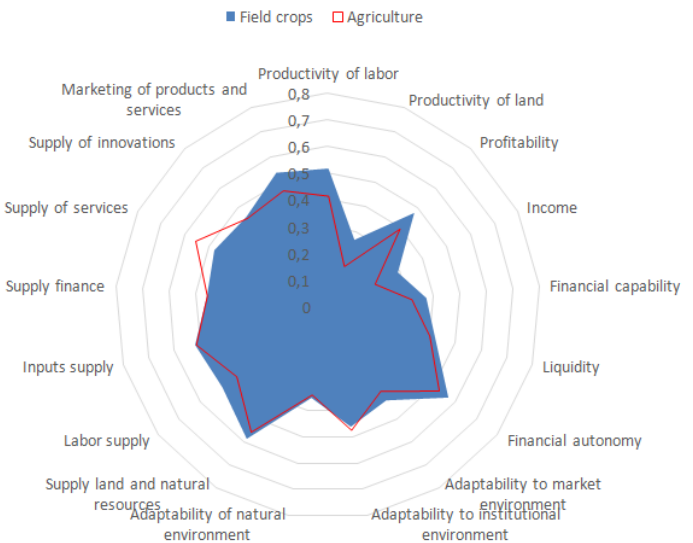

Figure 10. *Indicators for competitiveness of agricultural holdings in the sector "Field crops" in Bulgaria*
Source: Author's calculations

Many of the indicators of competitiveness of farms specializing in the cultivation of *vegetables, flowers and mushrooms* have values lower than the national average (Figure 11). However, in many respects, these farms have higher than average positions - profitability, adaptability of the market environment, efficiency in the supply of land and

natural resources, labor, materials, machinery and biological resources, services, and in the sale of products and services.

Main for maintaining the competitive position of this type of farms are high financial autonomy, efficiency in the supply of land and natural resources, labor, materials, equipment and biological resources, services and sales of products and services. The main factors for reducing the competitiveness of those specialized in the cultivation of vegetables, flowers and mushrooms are low productivity (0.11), productivity (0.16), profitability (0.09), financial capability (0.27) and adaptability to the natural environment (0.33).

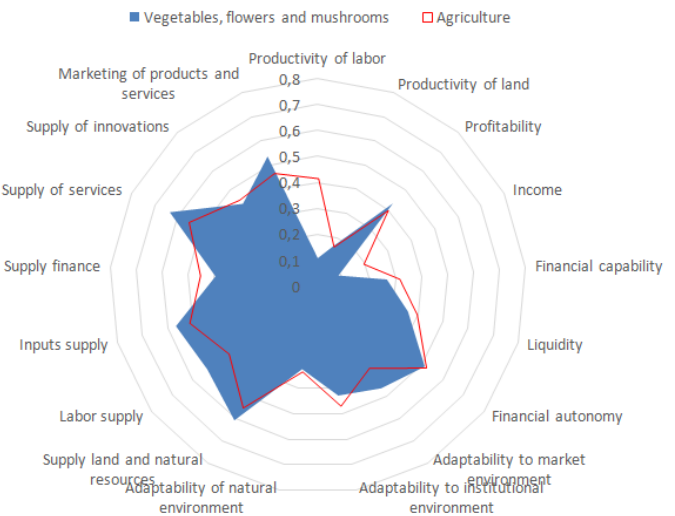

Figure 11. *Indicators for competitiveness of agricultural holdings in the sector "Vegetables, flowers and mushrooms" in Bulgaria*
Source: Author's calculations

The majority of indicators for the competitiveness of farms specialized in the cultivation of *permanent crops* have values lower than the national average (Figure 12). However, in some areas, these farms have better-than-average positions, such as financial autonomy, adaptability to the

institutional environment and efficiency in the supply of finance, services and innovation.

The competitiveness of this type of farms is maintained by high financial autonomy, adaptability to the institutional environment, efficiency in the supply of land and natural resources, services and innovation. The most important for the deterioration of the competitive position of the farms specializing in the cultivation of perennial crops are low productivity (0.14), profitability (0.19), financial capability (0.3), adaptability to the market (0.33) and natural (0.31) environment.

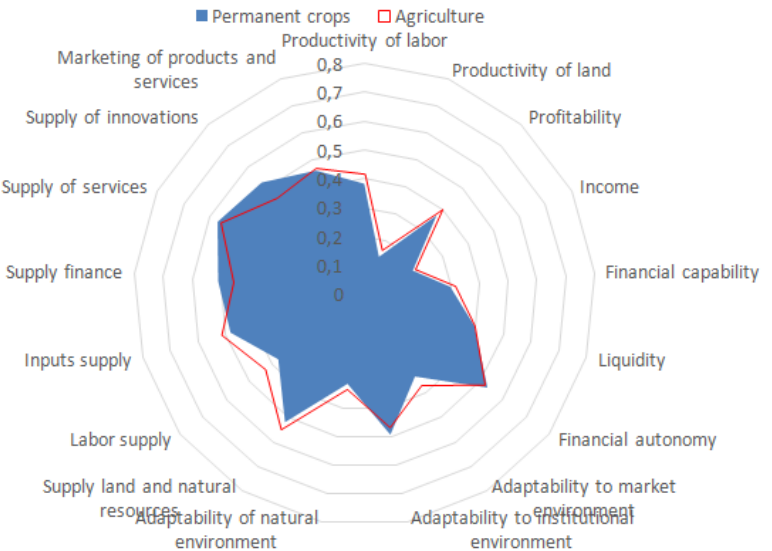

Figure 12. *Indicators for competitiveness of agricultural holdings in the sector "Permanent crops" in Bulgaria*
Source: Author's calculations

All indicators of competitiveness of farms specializing in *grazing livestock*have values lower than the national average (Figure 13). The low productivity (0.09), profitability (0.1), financial capability (0.24), liquidity (0.28) and adaptability to

the market (0.27), institutional (0.33) and natural (0.32) environment contribute the most to the unsatisfactory competitiveness of this type of farms. The main factor for raising the competitive position of farms in grazing animals is the high efficiency in their supply of services.

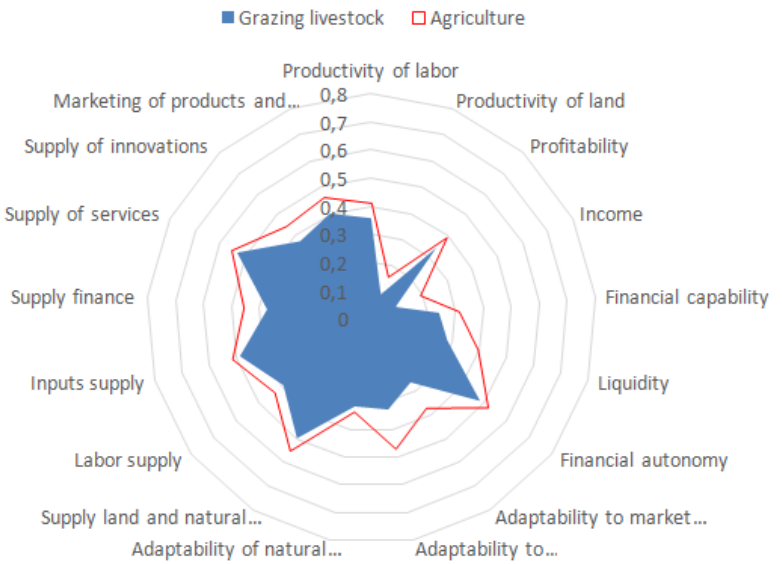

Figure 13. *Indicators for competitiveness of agricultural holdings in the sector "Grazing livestock" in Bulgaria*
Source: Author's calculations

Most of the competitiveness indicators of farms specializing in *pigs, poultry and rabbits* have values lower than the national average (Figure 14). However, in several respects, these farms have better-than-average positions, such as adaptability to the market and institutional environment, efficiency in the supply of land and natural resources, labor and services.

The most important for maintaining the competitiveness of this type of farms are the high efficiency in the supply of land and natural resources, labor and services. Critical for

the competitive positions of farms specializing in pigs, poultry and rabbits are low productivity (0.03), profitability (0.1), financial capability (0.25), liquidity (0.33) and adaptability to changes in the natural environment (0.31).

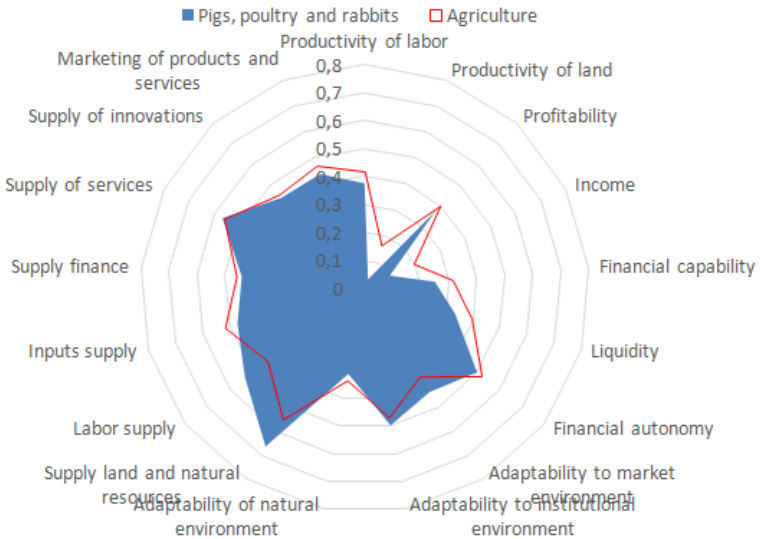

Figure 14. *Indicators for competitiveness of agricultural holdings in the sector "Pigs, poultry and rabbits" in Bulgaria*
Source: Author's calculations

Many of the indicators of competitiveness of farms specializing in *mixed crop* production have values lower than the national average (Figure 15). However, in many areas, this type of farms have relatively better than average positions, such as profitability, financial capability, liquidity, adaptability to the market, institutional and natural environment, and efficiency in the supply of land and natural resources, materials, equipment and biological resources. and in the realization of products and services.

Central to maintaining the competitiveness of these farms are high efficiency in the supply of land and natural resources, materials, machinery and biological resources and

services. At the same time, however, the competitive position of mixed crop farms is compromised by low productivity (0.24) and income (0.28), and close to the low level of adaptability to changes in the natural environment (0.34).

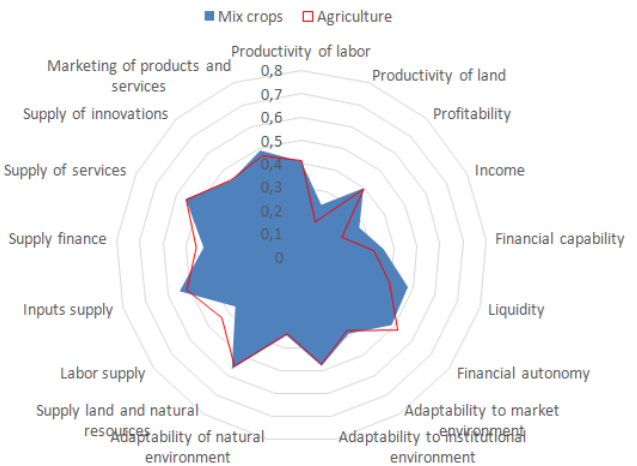

Figure 15. *Indicators for competitiveness of agricultural holdings in the sector "Mix crops" in Bulgaria*
Source: Author's calculations

Many of the competitiveness indicators of *mix livestock* farms are higher than the national average (Figure 16). The farms specialized in this field are superior to other farms in terms of productivity, profitability, financial capability, liquidity, adaptability to the institutional and natural environment, efficiency in the supply of finance and innovation, and in the sale of products and services. The other indicators of competitiveness of this type of farms are lower or around the average levels for the country.

The high adaptability to the institutional environment and the efficiency in the supply of finances and services contribute the most to maintaining the competitive positions

of the mixed livestock farms. At the same time, however, the indicators of productivity (0.17), profitability (0.2) and efficiency in labor supply (0.31) are low and limit the improvement of the overall competitiveness of these farms.

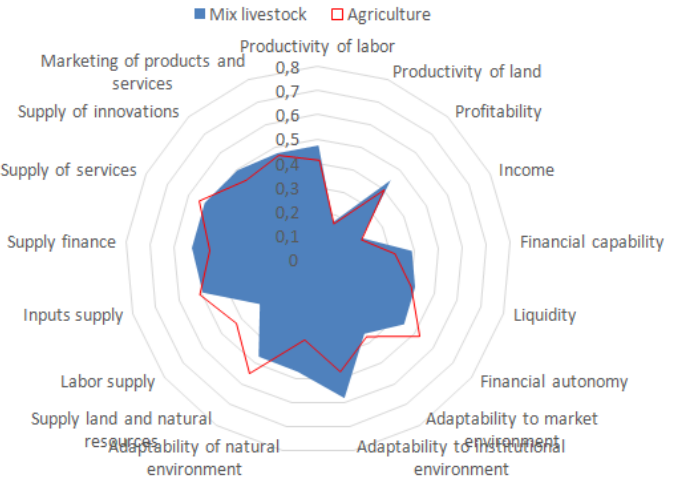

Figure 16. *Indicators for competitiveness of agricultural holdings in the sector "Mix livestock" in Bulgaria*
Source: Author's calculations

Almost all indicators of competitiveness of *mixed crop - livestock* farms are lower or close to the national average (Figure 17). These farms are above average only in terms of financial autonomy and efficiency in the supply of labor and services.

High financial autonomy and efficiency in the supply of land and natural resources, materials, machinery and biological resources and services contribute the most to maintaining the competitive position of this type of farms. At the same time, low productivity (0.17), profitability (0.18), financial capability (0.31), and adaptability to changes in the market (0.33) and natural (0.29) environment are critical for the competitiveness of mixed crop and livestock farms.

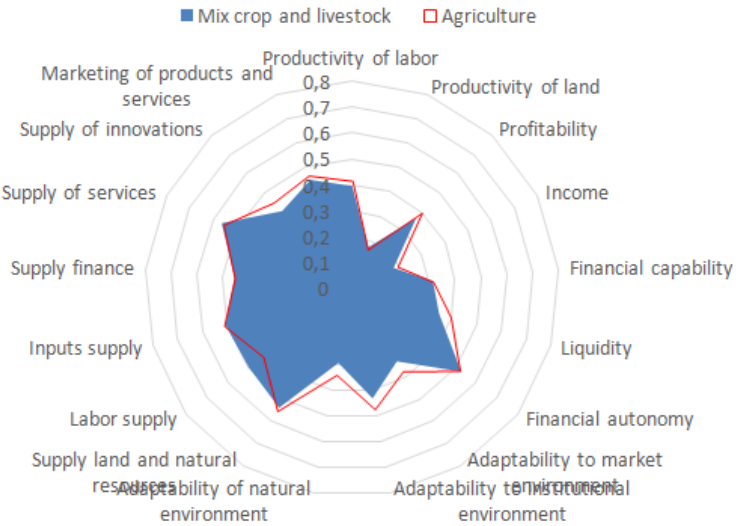

Figure 17. *Indicators for competitiveness of agricultural holdings in the sector "Mix crop and livestock" in Bulgaria*
Source: Author's calculations

Almost all indicators of competitiveness of farms specializing in *beekeeping* are higher than the national average, with the exception of indicators of productivity, profitability, income and efficiency in the sale of products and services (Figure 18).

The competitiveness of this type of farms is favored by the high level of financial autonomy, adaptability to the institutional environment, efficiency in the supply of resources, services and innovation. At the same time, however, low productivity and profitability are the factors that worsen the competitive position of beekeepers.

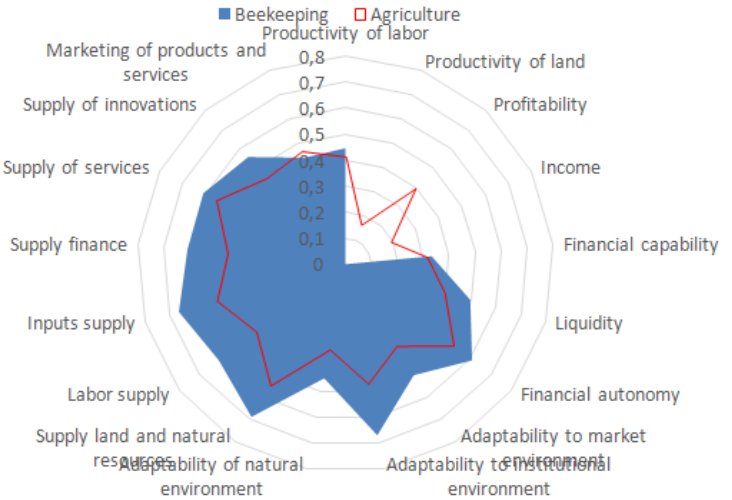

Figure 18. *Indicators for competitiveness of agricultural holdings in the sector "Beekeeping" in Bulgaria*
Source: Author's calculations

The assessment of competitiveness for agricultural holdings shows that the majority of those specialized in *field crops* (62.5%) and *mixed livestock* (72.22%) have a level of competitiveness above the national average (Figure 4). The lowest share of farms with competitiveness exceeding the national average is in the sectors of *grazing animals* (14.1%), *mix crop - livestock* (19.64%), *mix crops* (24.44%) and *bees* (one third).

There are also big differences in the share of farms in the different types of specialization with exceeding the average for the respective sub-sector (type) competitiveness. While in field crops 58.33% of farms are competitive above the average for this sector, in mixed crop - livestock farms they are only 19.64% (Figure 4). The share of farms with a competitiveness superior to that of the sector in herbivores (21.79%) and bees (one third) is also very low.

The largest share of farms with high competitiveness is in the sectors of bees (one third), field crops (29.17%), pigs, poultry and rabbits (a quarter) and mixed livestock (22.22%), and the smallest in farms specialized in grazing animals - only 1.28% (Figure 3). At the same time, the share of farms with low competitiveness in each type of specialization is significant - field crops, pigs, poultry and rabbits, and mixed crop-livestock - 37.5% each, vegetables, flowers and mushrooms - 36.67%, perennials and bees - 33.33 %, mix crops - 28.89%, and grazing animals - 21.79%. Only in mixed livestock farms there are no ones with low competitiveness.

There is a discrepancy between the assessments of the level of competitiveness in the present analysis, with the self-assessments of the managers of the surveyed farms with different specialization (Figure 19). While the majority of beekeepers (37.50%) believe that their farms are highly competitive, in other groups of farms this percentage is much lower - from 1.8% (mix crop and livestock) to 9% (perennials). No manager in field crops puts the farm he runs in the group of highly competitive ones. At the same time, the share of managers who assess their farm as low competitive is large - 30.43% for field crops, 21.43% for vegetables, flowers and mushrooms, 28.21% for perennials, 46.88% for grazing animals, 31.25% for pigs, poultry and rabbits, 22.22% in mix crops, 27.78% in mix livestock, 35.71% in mixed crop-livestock, and 12.5% in bees.

Therefore, independent multi-criteria evaluations such as those in this study would improve the awareness and management of farms that overestimate or underestimate their actual competitiveness.

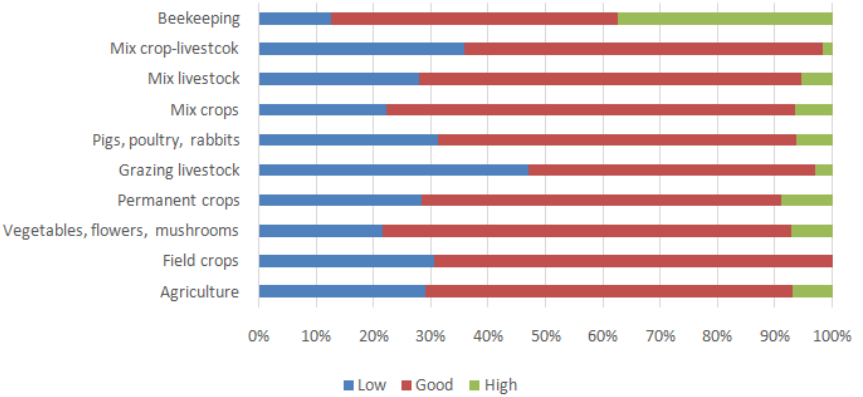

Figure 19. *How do you assess the competitiveness of the agricultural holding?*
Source: Survey with agricultural producers, 2020

The survey of managers found that there are large differences in the share of farms of each type of specialization with different levels of competitiveness indicators. A significant part of the farms in all subsectors have productivity and profitability, well below the national average (Table 3). Also, a large proportion of farms specializing in perennials, pigs, poultry and rabbits, and beekeeping have low productivity and profitability.

The largest share of farms with low financial capability is in the following sectors: vegetables, flowers and mushrooms (46.43%), permanent crops (40.26%), grazing livestock (51.61%), pigs, poultry and rabbits (50%), and beekeeping (44.44%) (Table 4). Most farms with high dependence on external financing (loan, subsidies, etc.) are in the groups of herbivores (31.25%), mixed crop (27.91%) and mixed livestock (27.78%). The most significant is the share of farms with low ability to pay their current obligations in: vegetables, flowers and mushrooms (31.03%), grazing animals (43.75%), pigs, poultry and rabbits (every third) and mix crop and livestock (32.14 %).

Many farms in different types of specialization have insufficient potential to adapt to changes in the market, institutional and natural environment (Table 5). The largest share of farms with low adaptability to changes in the market environment (demand, prices, competition, etc.) are in the following sectors: permanent crops (37.66%), grazing animals (every second), mixed livestock, mixed crop-livestock, and bees (one third each). Most farms with insufficient adaptability to the institutional environment and restrictions (state and European requirements for quality, safety, environment, etc.) are among those specializing in grazing livestock (34.38%), and mixed crop-livestock farms (23.21%). There is also a significant share of farms with low ability to adapt to changes in the natural environment (warming, extreme weather, drought, sleet, etc.), which varies from 22.22% in mixed livestock and bees, to 46.43% of all mixed crop - livestock farms in the country.

The survey found that the largest share of farm managers who believe that their farms are low sustainable in the medium term, among those specializing in: field crops (20.83%), grazing animals, and pigs, poultry and rabbits –by 31.25% (Figure 6).

The survey also found that a significant proportion of farms in the areas of perennials (35.9%), herbivores (40.63%), mixed crops (37.78%) and mixed livestock (44.44%) have serious problems and difficulties in effectively providing the needed labor force (Table 6). There are also many farms that have serious problems and difficulties in effectively providing the necessary funding - 31.03% of all farms specializing in growing vegetables, flowers and mushrooms, 35.48% - of those in grazing animals and 28.89% - of mixed crops. In addition, a large part of farms with grazing animals (43.75%), pigs, poultry and rabbits (31.25%), and mixed crop and livestock (32.14%) have serious problems and difficulties in effectively providing the necessary innovations and

know-how. There are also many farms with perennial crops (22.08%), grazing animals (25.81%), pigs, poultry and rabbits, and bees (a quarter each), which have serious problems and difficulties in the effective sale of their products and services.

Factors determining the competitiveness of agricultural holdings

The conducted survey and assessment of competitiveness gives the opportunity to identify personal, organizational, market, institutional and others factors that affect (and predetermine) the competitiveness of agricultural holdings in the country.

The share of farms with high competitiveness with female managers (20.37%) is higher than the national average and on farms with male managers (16.33%) (Figure 20). At the same time, the share of farms with women managers with low competitiveness (32.41%) is lower than the national average and of farms with men managers (37.24%). Also, half of the group-owned farms are highly competitive, and there are no low-competitive farms among this type of farms. This proves that women's and group management is more effective in terms of competitiveness and their expansion would improve the overall competitiveness of Bulgarian farms.

The highest share of farms with high competitiveness is among managers over the age of 65 (26.67%) (Figure 20). It is also higher than the average and relative share of farms with high competitiveness of managers aged 56 to 65 (20.51%). At the same time, the relative share of farms with high competitiveness of managers - young farmers (up to 40 years old) is the smallest and below the national average. This confirms that practical experience, which improves with age, is an important factor in raising the competitiveness of farms.

Education is also a critical factor for increasing the competitiveness of farms. The share of farms with high competitiveness with managers with secondary (33.33%) and higher (29.03%) agricultural education is significantly above the national average and from farms with managers without agricultural education, with lower or other education (Figure 20).

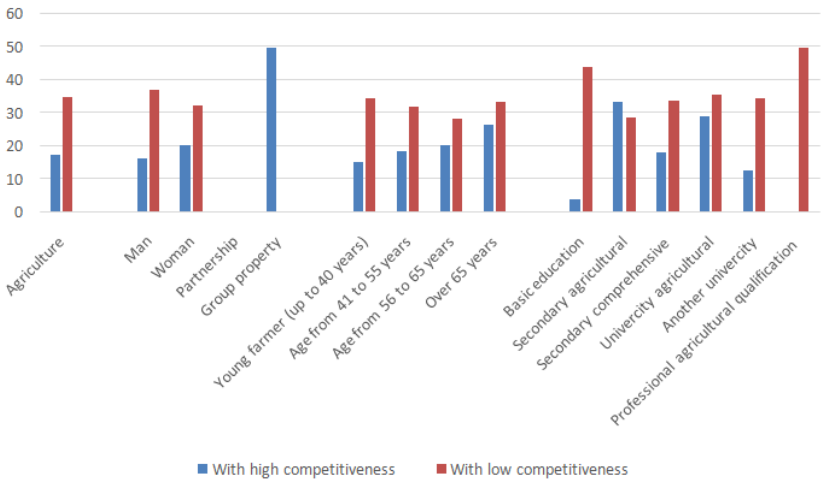

Figure 20. *Share of farms with high and low competitiveness depending on gender, age and education of managers (owners) in Bulgaria*
Source: Author's calculations

According to the majority of managers of the surveyed farms, the most significant factors for increasing the competitiveness of their farms are: market conditions (supply and demand, prices, competition) (73.35%), received direct state subsidies (56.43%), access to knowledge, consultations and advice (48.9%), participation in government support programs (47.96%), available information (33.86%), financial opportunities (31.97%), and opportunities for benefits in the near future (26.65%) (Figure 20).

Figure 21. *Which factors contribute the most to increasing the competitiveness of your farm (% of farms)?*
Source: Survey with agricultural producers, 2020

According to the majority of managers for increasing the competitiveness of farms, the most important instruments of public policies are: direct subsidies per land area (59.87%), national topups for products, animals and others (46.08%), support for small and medium-sized farms (44.20%), vocational training and advice (42.01%), modernization of agricultural holdings (41.38%), state and European instruments (39.18%), support for holdings of young farmers (29.47%), and green payments (24.14%) (Figure 22).

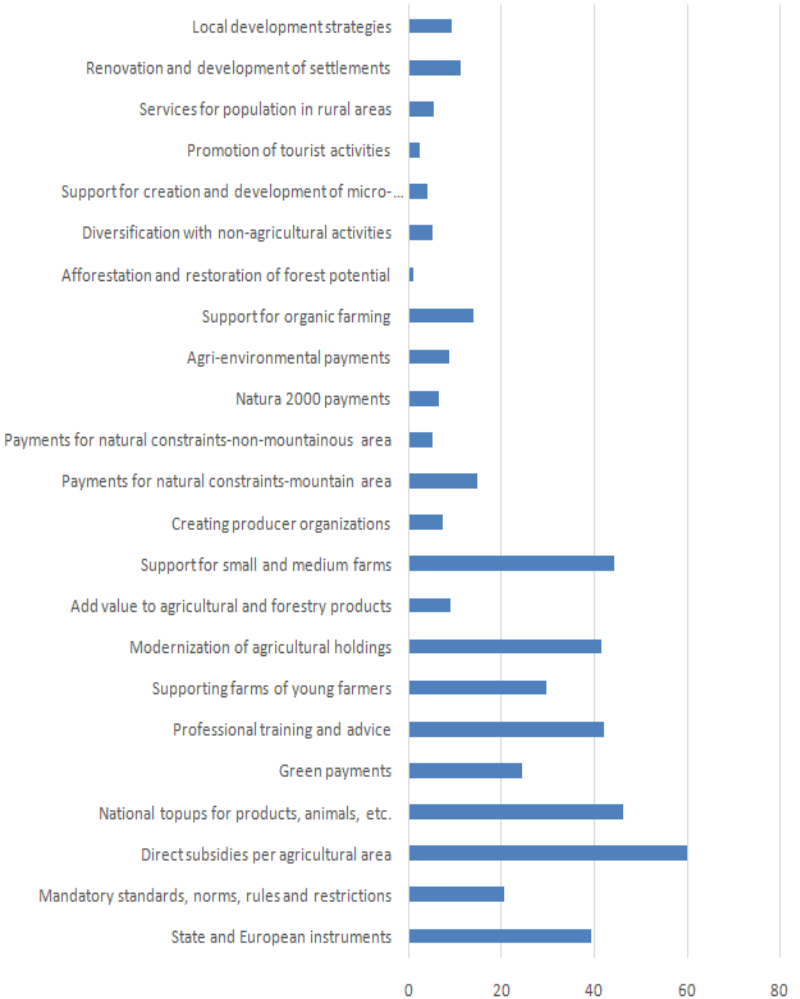

Figure 22. *Which policy instruments increase the competitiveness of your farm the most (% of farms)?*
Source: Survey with agricultural producers, 2020

Regarding the intentions of the farms in the near future, the majority of managers plan to *expand the current agricultural activities* (53.92%), and a significant part to *keep the current activities* (49.53%) (Figure 23). Less than 3% of farms plan to *limit current activities*, which shows that the

majority of Bulgarian farms have good competitive positions and plan to maintain or expand their activities.

A large part of the farms also intend to *participate in state support measures* (39.5%). Obviously, state support will continue to be an important factor in supporting and increasing the competitiveness of country's farms.

Other development strategies, which are also envisaged by a large number of farms, are: implementation of their initiative (15.99%), introduction of new products, services, etc. (13.48%), diversification of farm activity (12.54%), introduction of new methods (11.91%), integration closely with the buyer of the farm (11.29%), and introduction of new technologies and know-how (11.29%).

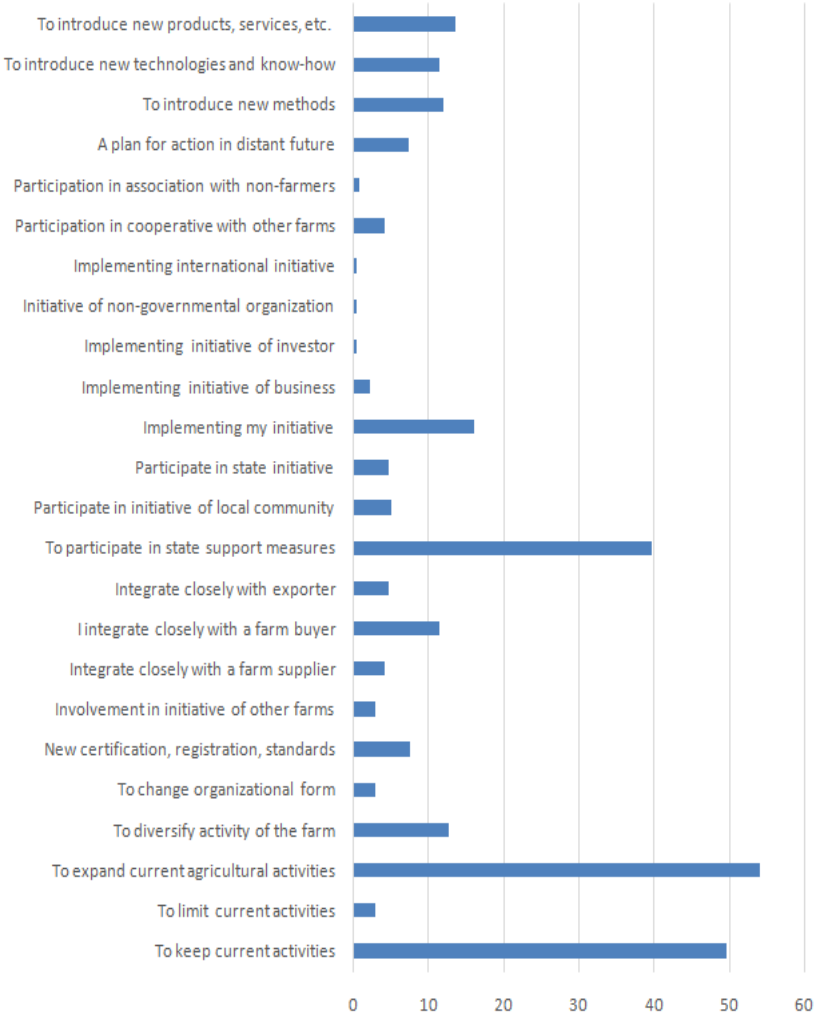

Figure 23. *What are your intentions in the near future related to your farm (% of farms)?*
Source: Survey with agricultural producers, 2020

According to the majority of managers, when introducing an *innovative business model in agricultural management*, competitiveness will increase on average (31.01%) (Figure 24). For a relatively large part of the farms the introduction of such a model will significantly increase their

competitiveness (22.15%), and the forecast for weak (16.14%) and no change (7.91%) makes less than the managers. At the same time, however, many managers cannot answer such a question (22.78%) due to the large uncertainties associated with the implementation of innovative models in the agricultural business.

Holdings with different specializations have different assessments of the likely effect on competitiveness from the introduction of an innovative business model for farm management. The majority of farms specializing in field crops (41.67%), perennials (28.21%), mixed crop (35.56%), mixed livestock (55.56%), mixcrop-livestock (32.73%) and beekeeping (37.5%) expect an average increase in competitiveness. For the majority of farms specializing in grazing animals (28.13%), and pigs, poultry and rabbits (43.75%) on the other hand, it is difficult to make any predictions in this regard.

The largest share belongs to farms that expect a significant increase in their competitiveness after introduction of an innovative business model, in mixed crop production (31.11%), grazing animals and beekeeping (one in four), and vegetables, flowers and mushrooms (24.14%).

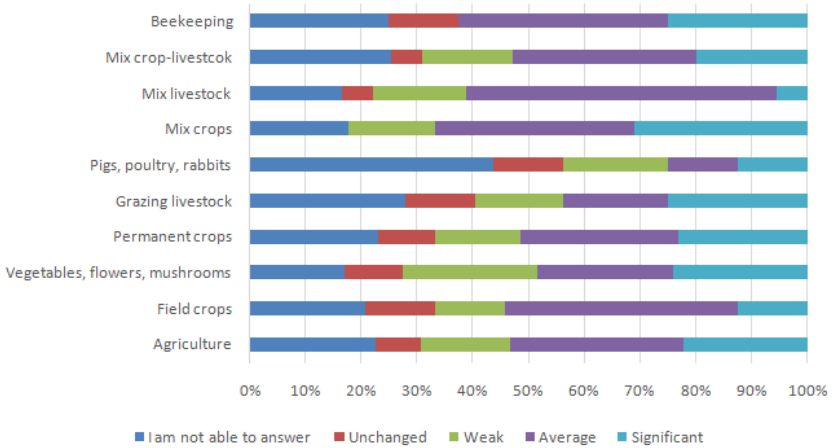

Figure 24. *By introducing an innovative business model in the management of your farm, how will the competitiveness (% of farms) increase?*
Source: Survey with agricultural producers, 2020

Conclusion

The multi-criteria assessment of the level of competitiveness of agricultural holdings in Bulgaria found that it is at a good level, as the low adaptive potential and economic efficiency contribute to the greatest extent to diminishingthe competitiveness of local producers. Particularly critical for maintaining the competitive position of farms are low productivity, profitability, financial capability and adaptability to changes in the natural environment, in which areas should be directed public support for farms and their management development strategies.

More than a third of all farms in the country have a low level of competitiveness, and if timely measures are not taken to increase competitiveness by improving the management and restructuring of farms, adequate state support, etc., a large part of Bulgarian farms will cease to exist in the near future. The most competitive are the farms

in the beekeeping sector, followed by field crops, mixlivestock and mix crop production, and the lowest on the farms specializing in grazing animals.

The most significant factors for increasing the competitiveness of Bulgarian farms at current stage of development are market conditions (supply and demand, prices, competition), direct government subsidies, access to knowledge, advice and counseling, participation in government support programs, available information , financial opportunities, and opportunities for benefits in the near future.

The proposed approach to assessing the competitiveness of farms should be refined and applied more widely and periodically. The analyzes should also cover holdings of different legal type, size, ecological and geographical location, etc. The accuracy and representativeness of the information used should also be enhanced by increasing the number of surveyed farms, applying statistical methods, special "training" of those conducting and participating in the surveys, etc. All this requires closer cooperation with producer organizations, national agricultural advisory service and other stakeholders, and improvement of the system for collecting agricultural information in the country.

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6 Diagnosis of the agricultural information, training and advices system in Bulgaria

Introduction

Stimulating and sharing knowledge, innovation, digitalization and promoting their greater use" is set again as one of the strategic (a "horizontal") objective in the new programming period 2021-2027 for implementation of the European Union (EU) Common Agricultural Policy (CAP) (European Commission, 2018). In many other countries, regular in-depth analyzes of the state, efficiency and development factors of the Agricultural Knowledge and Innovation System (AKIS) are made (Anandajayasekeram & Gebremedhinp, 2009; Antle *et al.*, 2017; Chartieret *et al.*, 2015; EIP-AGRI EU SCAR, 2012; FAO, 2019; Touzard *et al.*, 2015; Özçatalbaş, 2017; USDA, 2019; Weißhuhn *et al.*, 2018; World Bank, 2006; Virmani, 2013).

In Bulgaria there are only partial analyzes of the individual elements of this complex system (Башев 2020; Башев и др. 2014; Башев и Михайлова, 2019; Bachev, 2020;

Bachev & Labonne, 2000; Bachev & Mihailova, 2019). The reason for later is the lack of enough official statistics and other information as well as "sufficient" public interest in the development of this important system.

The article tries to make a comprehensive analysis of the state and development of the system of information, training and advices in agriculture in Bulgaria in the years after accession of the country to the European Union (EU). The aim is to identify the major trends, assess efficiency, specify modern issues, compare situation with other EU countries, and support policies in the next programming period[1].

Like most of the other EU member states, there is insufficient official (statistical, reporting, etc.) information on the status and development of this complex system, its individual components, and the complex relationships between its participants. All this makes it difficult both to analyze the state and development of this important national system and to make comparative analyzes with other member states of the Union.

The study uses all available official (statistical, report etc.) information as well as results of a specially organized experts' evaluation (2019). The later involved 32 leading experts from the research institutes of the Agricultural Academy (AA) and Bulgarian Academy of Sciences (BAS), agrarian and other universities, National Agricultural Advisory Service (NAAS), and major professional organizations of agricultural producers.

Identifications of the agents of AKIS in Bulgaria

In Bulgaria AKIS is composed of diverse and numerous individuals and organizations involved in the process of

[1] In fact, that analisis is being used for identifying public intervention needs and measures in the 2021-2027 Program for Agrarian and Rural Development of Bulgaria (Иванов, Башев и др., 2020).

generating, sharing, disseminating and implementing of information, knowledge and innovations in the sector. In addition to diverse type of farmers and agricultural holdings (subsistent, semi-market, market, individual, family, cooperative, corporative, etc.), this complex system includes research institutes, universities and professional schools, national agricultural advisory service, private consultants, specialized consulting, training and innovation firms, professional organizations of agricultural producers, non-governmental organizations, suppliers of machinery, chemicals and innovations, food chains, processors and exporters of agricultural produce, government agencies, local authorities, non-governmental organizations and interests groups, media of various kinds, international agents and organizations, private individuals, etc. (Figure 1).

Figure 1 shows the main agents involved in the Agricultural Knowledge Sharing and Innovation System of Bulgaria. For a greater clarity only relationships of one organization (AA) with other organizations in this complex network of multilateral and complex relationships are highlighted.

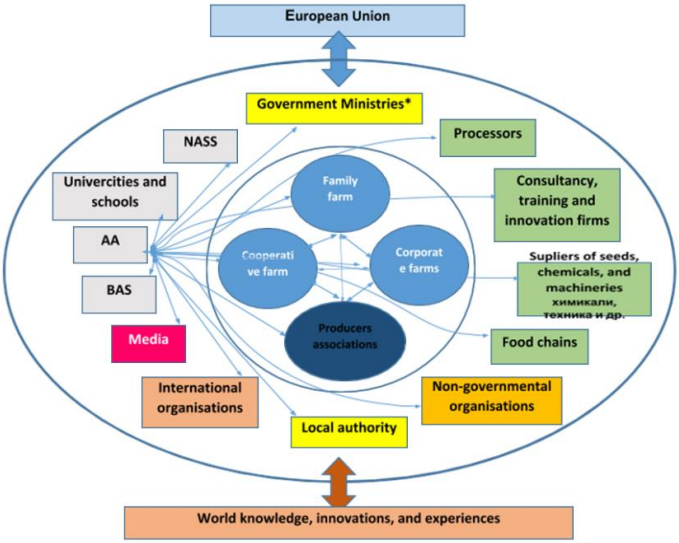

Figure 1. *Main actors and relationships in the national Agricultural Information, Knowledge Sharing and Innovation System of Bulgaria*

Notes: Leading among them are: Ministry of Agriculture, Food and Forestry, Ministry of Education and Science, Ministry of Industry, and Ministry of Environment and Waters

Source: the author

Analysis of the system of education and training of agricultural producers

In 2014 the professional education in the field of agriculture and forestry covers 92 institutions (technical schools, high schools, etc.) and more than 880 vocational training centers with licensed professions and specialties for vocational education and training in the fields of agriculture, veterinary medicine, forestry and food technologies (ПРСР 2014-2020, МЗХГ). Subsequently, some of them were closed due to the low interest in the specialties, the number of students enrolled and dropped out, etc.

During the period 2013-2018 on average annually 870 persons receive a Level-3 qualification in the field of

Agriculture, Forestry and Fisheries, and 144 in Veterinary Medicine (НСИ). For the same period, 633 people also receive a Level-2 qualification in Agriculture, Forestry and Fisheries. Agrarian graduates represent 6.14%, 1.08% and 16.25% respectively of the total professional qualifications in the country.

The number of persons acquiring in 2018 the professional qualifications Level 3 in the fields of Agriculture, Forestry and Fisheries and Veterinary Medicine is higher than the beginning of the period by 2% and 6% respectively (Figure 2), with a decrease in the total level of qualifications acquired in the country by 13% (НСИ). The number of graduates with vocational qualifications of Level 2 in general and in the field of Agriculture, Forestry and Fisheries have been significantly reduced since 2013, as the reduction in the agrarian sphere is less than the overall graduates in that level.

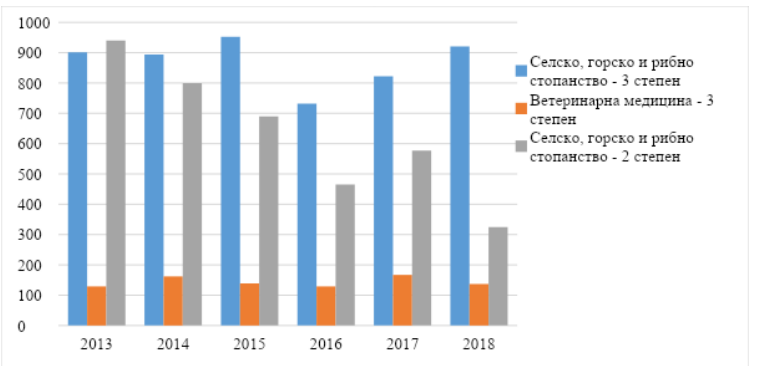

Figure 2. *Graduates of the II and III Levels programs for professional qualification in different fields of education (number)*
Source: НСИ

The higher education in agrarian specialties is carried out at several universities offering similar qualifications and competing for a limited number of students – e.g. Agronomy and Agrarian Economics is offered in 6 universities and colleges, etc.

The number of undergraduate students in Agrarian Sciences, Forestry and Aquaculture and Veterinary Medicine in 2017 is well above the 2007 levels for Bachelor and Master degrees (Figure 3). Moreover, the relative share of these two branches of the agricultural education relatively increased in the total number of students in the country during the period - for Bachelor's Degree in Agrarian Sciences, Forestry and Aquaculture from 1.89% to 2, 48%, for the Master's Degree Program in Agricultural Sciences, Forestry and Aquaculture from 0.67% to 1.1%, while for the Master's Degree in Veterinary Medicine it is relatively stable (НСИ). This confirm the aspirations of many young people to increase their education in agrarian sphere.

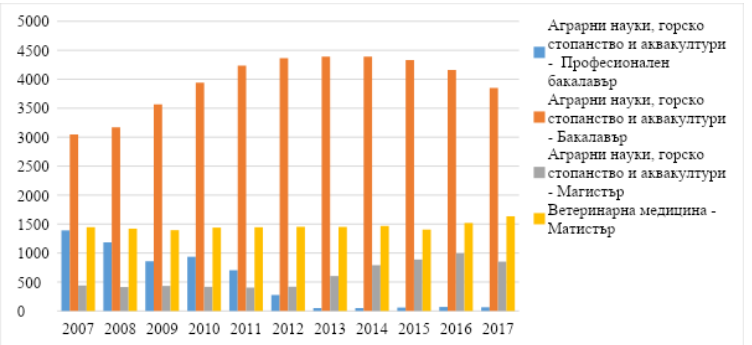

Figure 3. *Number of undergraduate and graduate students and fields of education*
Source: НСИ

However, there is no information on how many of the graduates of agricultural specialties in vocational and higher education institutions work in the agricultural sector. It is well known, for example, that a small number of university graduates work subsequently in their fields of education. Moreover, discussions regarding the (low) quality of education and the efficiency of schools adaptation to the needs of the business have been constantly on the agenda.

Available data on the agricultural training of the managers of agricultural farms in Bulgaria show that in the first years after the accession to the EU, only a small number of them have basic or full agricultural training, most of them being only with practical experience (Figure 4). Moreover, in 2010, only 1.3% of the farm managers had undergone some form of training in the last 12 months (Figure 5). By this indicator, Bulgaria is among the most lagging behind countries in the EU, along with Romania, Greece and Cyprus.

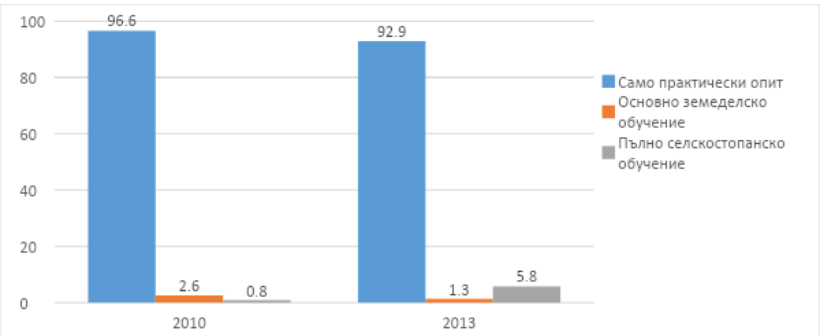

Figure 4. *Agricultural training of the managers of agricultural farms (%)*

Source: Eurostat

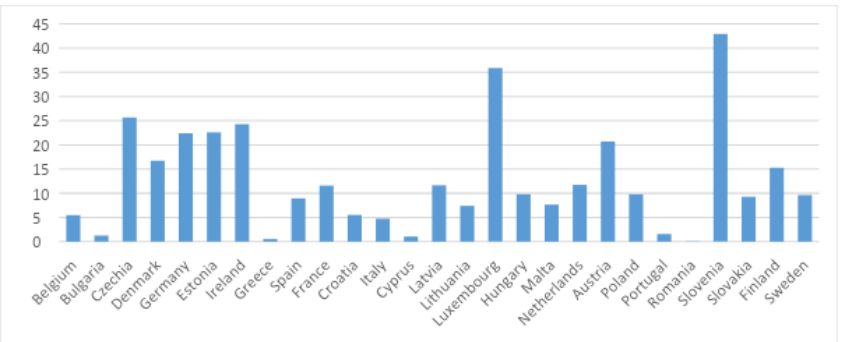

Figure 5. *Share of holdings with vocational training by manager in last 12 months in EU member states in 2010 (%)*

Source: Eurostat

As a result of the undertaken measures for public support during the period 2010-2013 the share of managers having completed full agricultural training increased from 0.83% to 5.8%, while those with basic agricultural training and only practical experience decreased slightly. At the end of the First programming period for the implementation of the CAP in the country almost 93% of all farm managers are only with practical experience and without any agricultural training.

The relatively small proportion of the farm managers who have completed basic or full agricultural training (7.12%) require significant public intervention for training and consultations of agricultural producers. With the exception of Romania, Greece and Cyprus, all other EU countries far outperform Bulgaria in the extent of training of farm managers (Figure 6).

Figure 6. *Agricultural training of farm managers in EU member states in 2013*

Source: Eurostat

Since 2007, agricultural and rural development programs have been a major tool for public support for the training and consultations of farmers to successfully adapt to the ever-changing economic, market, institutional and natural environment.

The total amount of public funds spent under the RDP 2007-2013 under Measure 111 "Vocational training, information activities and dissemination of scientific knowledge", Measure 114 "Use of advisory services by farmers and forest owners" and Measure 143 "Provision of advice and agricultural consultancy in Bulgaria and Romania "amounts to 15 236 905 Euro (MAF, 2018). It represents 1.65% of the total amount of the public expenditures under Axis 1 and 0.5% of the total budget of the program.

Bulgaria is in the group of EU countries (along with Greece, Poland and Romania), in which these three measures account for the smallest share in the total expenditures of Axis 1 and of the RDP 2007-2013 as a whole (Figure 7). Developed European countries such as Austria, Netherlands, France, etc. attach a greater importance to farmers' consultations and training and devote a much larger share of the Axis 1 and RDP budgets to these activities, as majority implement more measures related to them.

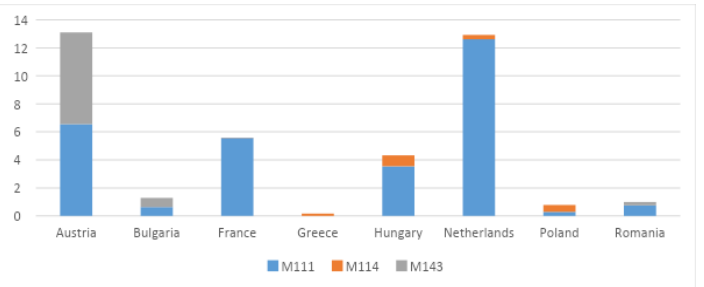

Figure 7. *Share of public expenditures for Measures 111, 114 and 143 in total public expenditures for Axis 1 of Rural Development Programmes 2007-2013 in selected EU countries (June 2015)*

Source: ENRD

Measure 111 represents 0.99% of the public expenditures in Axis 1 and 0.3% of the budget of the PRD. For the entire period of implementation (2008-2015), 91 contracts were concluded under the measure with various training

organizations for financial assistance, totaling BGN 30 685 570. The training is provided by AA, NAAS, universities, private and professional organizations, etc. In order to increase the efficiency of the RDP, the vocational training was introduced as a prerequisite for the participation of farmers without agricultural education in some of the other public support measures - Measure 112 ("Setting up farms for young farmers") and Measure 214 ("Agri-environment payments").

During the implementation of the measure, the initial budget was reduced four times, which is due to a greater initial interest and unrealistic planning, lack of training providers, insufficient promotion of the activity and reluctance of the producers to study away from the farm.

In the course of implementation of the Measure 111 "Vocational training, information activities and dissemination of scientific knowledge", a total of 40 062 farmers were trained, with an average training duration of 5.1 days (Table 1). This represents almost 16% of the total number of farms in the country and just over 52% of the number of registered farmers in 2013. This is a significant success given the large number of farmers in the country and their (low) qualification level. The public cost per trained person is EUR 228.7 and one-day training EUR 44.9, which demonstrates the high efficiency of this public intervention.

Table 1. *Implementation of measure 111 of the RDP 2007-2013*

Area of training	Total trained participants	Number of days of training	Public funds paid, thousand EUR	Duration of training per student, days	% in total trained	% in total days	% of total cost
Administrative, management and marketing skills	5892	32020	1347	5,4	14.71	15.70	14.70
ICT in agriculture	233	1921	53	8,2	0.58	0.94	0.58
Technical knowledge and skills - new echnological processes and machines, innovative practices	14898	85500	3407	5,7	37.19	41.93	37.19
New standards	170	2247	39	13,2	0.42	1.10	0.43
Quality of production	100	2163	23	21,6	0.25	1.06	0.25
Sustainable management of natural resources and environmental protection	17157	75874	3923	4,4	42.83	37.21	42.82
Others	1612	4184	369	2,6	4.02	2.05	4.03
TOTAL	40062	203909	9161	5,1	100	100	100

Source: Последваща оценка на ПРСР 2007-2013 г., МЗХ, 2018

The over-passing of the planned indicators is high - by 158% for the indicator number of participants and by 54% for the number of training days. The participation of farmers in the training under this measure is high given the opportunity to acquire new knowledge, improve qualifications, transfer of knowledge and experience, as well as the mandatory requirements for participation in other measures of the program.

A positive result in the implementation of the activities under that measure is the high participation of young people up to 40 years and women. Trainees between the ages of 18 and 40 are 60% of all trainees (M3X). In 2013, the number of farm managers under 40 is between 30-35000, which means that over 70% of them have received training. Women enrolled in the training are 35% of all trained, indicating that

one quarter of women managers in the country have received training during the period.

The biggest number of participants in the trainings and information events are in the thematic area "Sustainable management of natural resources and environmental protection" (Table 1). This area represents 42.8% of all trained persons and expenditures and 32.7% of all training days, with an average of 4.4 days of training.

The second most popular topic is "Technical knowledge and skills - new technological processes and machines, innovative practices", which represents 37.2% of the number of trainees and total expenses and 41.9% of the training days, with an average length of training of 5 ,4 days.

The third topic that farmers are most interested in is "Administrative, Management and Marketing Skills", in which 14.7% of the participants are trained, 15.7% of the training time is engaged, with an average duration of 5.4 days.

An average for the EU countries, these three thematic areas also dominate, along with "Others", but take a different relative share than in Bulgaria (Figure 8). In more developed countries such as Austria, France and Poland, and in the Union as a whole, product quality training has a significant share. In some countries in Eastern Europe, such as Romania and Hungary, the vast majority of participants in the training have preferred "Administrative, management and marketing skills".

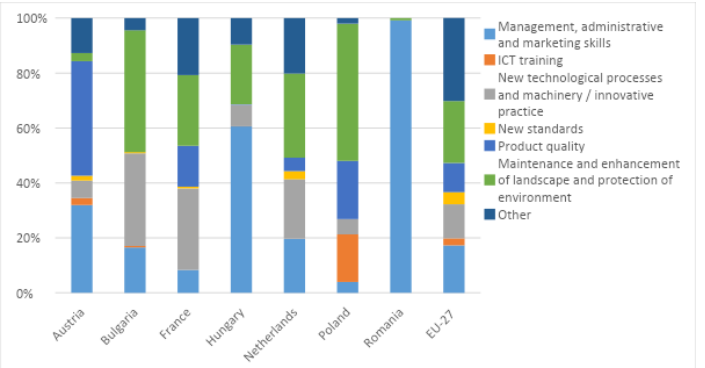

Figure 8. *Measure 111 Vocational training and information actions of Rural Development Programmes 2007-2013 of selected EU countries (June 2015)*
Source: *ENRD*

In terms of the number of training days, Bulgaria is 2.4 times above the EU average, well above that in developed countries such as Austria, the Netherlands and Poland, and well below the duration in Hungary and Romania (Figure 9). At the same time, the public expenditures of one participant and one day of training in the country are significantly lower than the average for the Union and some of the compared countries. This is an indicator of the higher (economic) efficiency of the organization of training compared to other European countries.

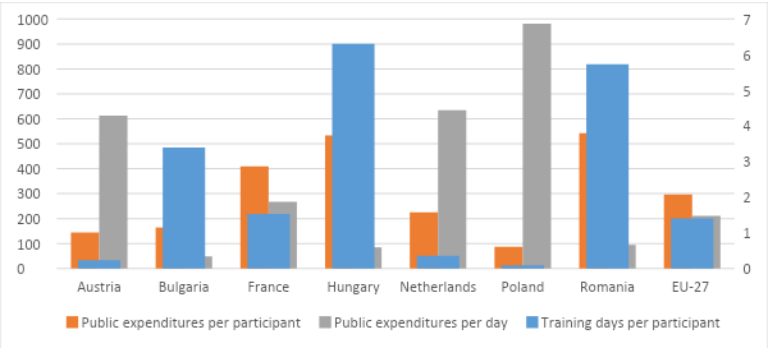

Figure 9. *Number of training days received and Public Expenditure per participants and training day of Measure 111 in EU countries, June 2015 (Number, Thousand Euro)*

Source: ENRD

The RDP 2014-2020 also gives a priority for the "Knowledge transfer and information actions" (Measure 1), "Consultation services, farm management, and transfer of farms" (Measure 2) and "Cooperation" (Measure 16), which respectively represent 0.87%, 0.15% and 1.12% of the total budget of public funds. Compared to the EU average and most Member States, the relative share of expenditures for co-operation, knowledge transfer and advisory services is significantly lower in Bulgaria (Figure 10). The part of this component of the budget in the country is similar to Germany and exceeds only that of a few countries (Croatia, Latvia, Romania and Cyprus).

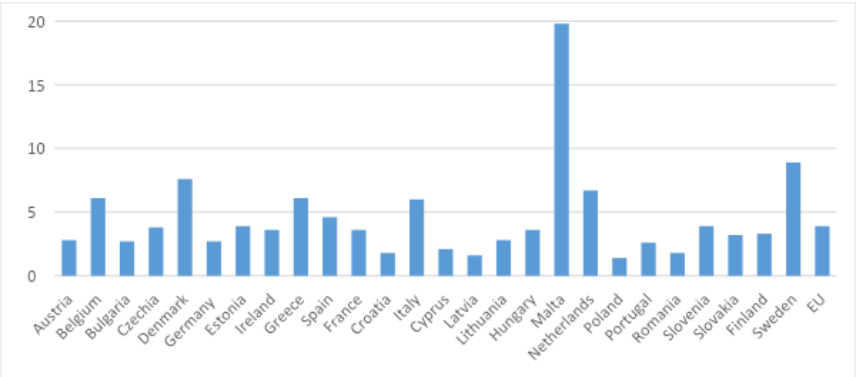

Figure 10. Percentage of expenditure under Measure 1, Measure 2 and Measure 16 in relation to the total expenditure for the RDP 2014-2020 in EU countries
Source: ENRD

The implementation of the main activities under the individual measures in the country is significantly behind in comparison with other European countries. For example, due to the delay of competitions, trainings have not been supported so far. There are also no funded EIP projects of stakeholder groups, researchers, consultants and businesses within the European Innovation Platform[2]. At the same time, many of these promising forms of knowledge sharing and innovation have already been established and are successfully operating in 15 other EU countries. With the largest number of EIP operational groups in place, are the older developed member states - Germany, the Netherlands, Italy and Spain (Figure 11).

[2] The first call for applications for the Sub-measure 16.1. "Support for the formation and functioning of operational groups within the EIP" under measure 16 "Cooperation" of the RDP 2014-2020 was published on 17.10.2019. There are a good numbers of proposals submitted but up to date there are no selected projects for funding.

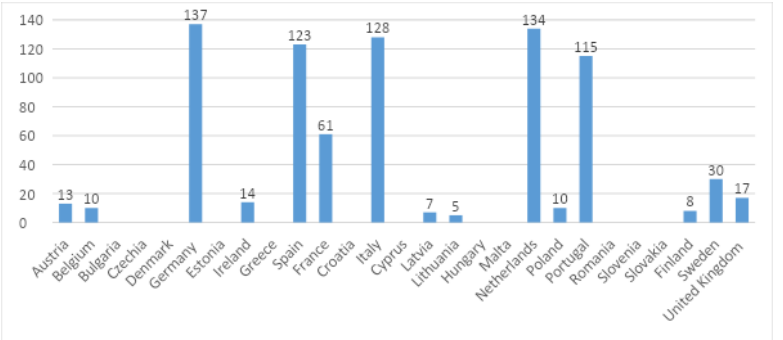

Figure 11. *Number of EIP Operational Groups in EU countries (November 2018)*
Source: DG AGRI

In Bulgaria there is no information about the total number of PhD students in the agrarian and rural sector. Agricultural Academy is one among numerous institutions providing superior training at Doctoral level in Agricultural and related sciences like Economics, Business, Public Administration, rural development, etc. It trains PhD students for the needs of the Academy and other public and private organizations. Throughout the period, there has been a trend of increasing the number of successfully defended theses. By 2015, the total number of PhD students enrolled in AA has increased, which has declined in the last two years (Figure 13). At the same time, the relative share of the full-time PhD students is decreasing and that of the part-time students and so called independent preparation students increasing. This shows that the AA's role in training highly qualified specialists for the needs of scientific and other organizations in the country is increasing.

We can only presume that the similar trends exist in other organizations involved in PhD training in agrarian and rural sector like public and private universities, institutes of BAS, foreign and international (like EU JRCs) organizations, etc. Nevertheless, in the country there is no any information about the number of employed in agriculture out of total

completed PhD studies in the agrarian, rural and related fields.

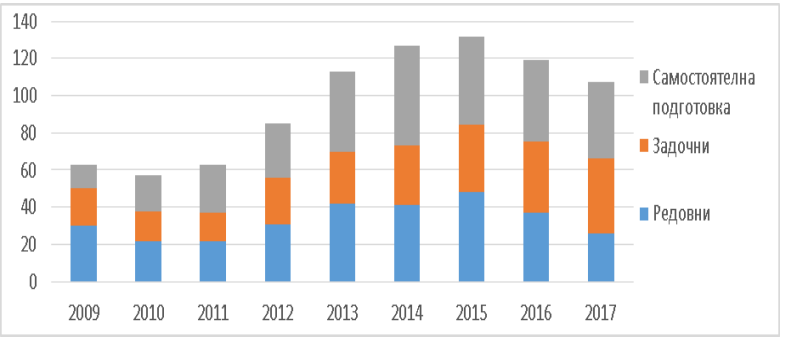

Figure 13. *Number of PhD students trained at Agricultural Academy*
Source: Annual reports of the Agricultural Academy

Despite the various forms of education and training offered and the considerable amount of public money spent, the participation rate in rural areas remains weak and steadily decreasing in the years after accession of the country to the EU (Figure 13). This trend is the opposite of that in most EU Member States except Romania and Greece. In terms of formal and non-formal education and training in rural areas, Bulgaria is also much worse than most of the EU countries (Eurostat).

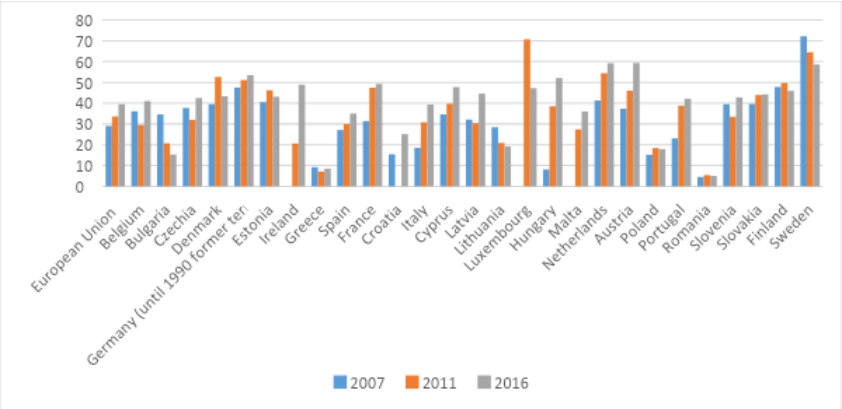

Figure 13. *Participation rate in education and training in rural areas in EU (%)*

Source: Eurostat

Evolution of the system of advices and consultations in agriculture

Supporting a specialized advisory service (NAAS) and consultation services to farmers is another major priority for the state during the years following country's accession to the EU. The RDP 2007-2013 includes two measures in this regard - Measure 114 "Use of advisory services by farmers and forest owners" and Measure 143 "Provision of advices and consultations advice in agriculture in Bulgaria and Romania".

Measure 114 is among the measures to which there is a little interest from the potential applicants. Only 96 contracts for support were concluded, with a total amount of public funds of BGN 191326, using only 36.9% of the planned expenditures (M3X). Funds spent under this measure represent only 0.004% of the total expenditures under Axis 1 of the program.

Under the Measure 143, as much as 0.65% of the total expenditures under Axis 1 and 0.2% of the total RDP expenditures were spent. Under this measure, the NAAS is

the sole beneficiary, effectively providing a full set of advisory services to eligible persons under measures 141 ("Supporting semi-subsistence farms in the process of restructuring"), 112 ("Setting up farms for young farmers"), 142 ("Creating Producer Organizations") and 214 ("Agri-environment Payments").

The NAAS is the main participant in the training and advice system of the country. The analysis of the activity and performance of the NAAS gives a good idea of the overall development of the public system of advices and training to farmers.

The NAAS employs experts organized in 3 departments at the central level ("Training, Information Activities and Analyzes", "Consulting Services for National and European Programs" and "Analytical Laboratory"), and 27 offices in each of the regions of the country. The NAAS offers a variety of consultations according to its program, including a comprehensive "package of consultation services" (from the establishment of the farm to its full servicing in agronomic, livestock and agro-economic aspects), organizes and conducts training for farmers, disseminates useful information and good practices, and assists in application for RDP projects. The NAAS supports the transfer and application of scientific and practical achievements in the field of agriculture and thus supports the link "research - agricultural business".

All consultations provided by the NAAS are free of charge to farmers, which helps to effectively share knowledge and innovation in the sector. The target groups targeted in recent years are mainly small and medium-sized farms, start-ups and young farmers, new production (organic production, ecological, etc.), producer organizations, etc. In this way are supported the involvement of all producers in the knowledge and

innovation system and the development of new forms and directions.

Funding of the activities of the NAAS is provided by budget subsidies and projects financed by various national, European and others organizations. Following the peak of the overall expenditures of the NAAS in 2011, their size was reduced by 2015, and has increased slightly over the last two years (Figure 14). At the same time, the number of NAAS staff has been steadily declining, with a 44% decrease over the last three years compared to 2010 (70 full-time employees).

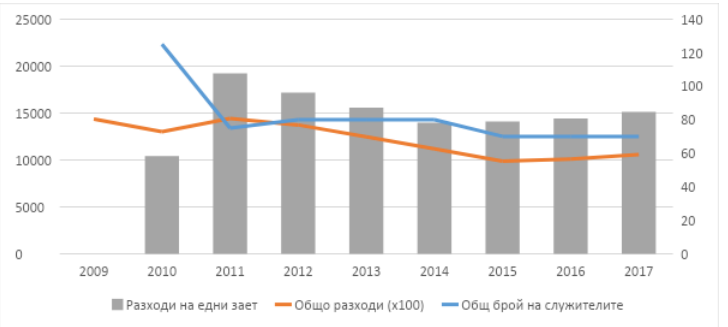

Figure 14. *Number of employees and the amount of expenditures of NAAS*

Source: Годишни отчети за дейността на НССЗ

The endowment with financial and material resources per one employed follows the dynamics of total expenditures. Compared to 2009, the expenditures per employee has been significantly higher in all the years so far, with their level steadily declining until 2014 and improving slightly in recent years. Reduced public support for the NAAS's activity is indicative of the reduced financial capacity of the state, the "reduced" need for advices, new public priorities, as well as directing of the budget subsidies to other organizations and activities.

Consulting agricultural agents (potential and actual farmers, other agriculture and rural entities and organizations) is a key task of the NAAS. Since the country's accession to the EU, the number of consultations provided by the NAAS has almost doubled, reaching nearly 93,000 (Figure 11). The majority of consultations (about 90%) take place at NAAS offices, but there is a slight increase in the share of on-site consultations on the farm. The latter give the opportunity to give specific advice, depending on the specific conditions of the farm visited.

Consulting agrarian agents (potential and actual farmers, other related to agriculture and rural areas persons and organizations) is a major task of the NAAS. Since the country's accession to the EU, the number of consultations provided by the NAAS has almost doubled, reaching nearly 93,000 (Figure 15). The majority of consultations (about 90%) take place at NAAS offices, but there is a slight increase in the share of on-site consultations on the farm. The latter give the opportunity to give specific advices, depending on the particular conditions of the visited farm.

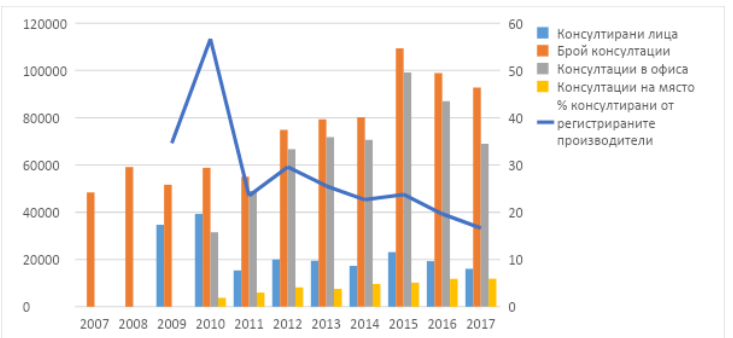

Figure 15. *Number of consulted persons and conducted consultations by NAAS*

Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

Compared to 2009-2010, the number of persons consulted is significantly reduced to 16,000 and varies significantly

from year to year. That is a result of both the improving qualification level of farmers (the need to consult a smaller number of farmers) and the development of alternative forms of service provision (private companies, suppliers of machinery and chemicals, producer organizations, scientific institutions, etc.).

In order to extend and facilitate farmers' access to advisory services and reduce their costs from 2015, the NAAS is implementing a new form of "field receptions" (consultancy days) in various settlements, usually far from the regional centers. By 2017, the number of field receptions increased to 1104, and the average number of attended persons decreased to 3.7, due to the decreased total number of participants and the increased number of receptions. This is an indicator for improving the consulting services of NAAS in all regions and settlements of the country.

In recent years, the share of farmers consulted by the NAAS in the total number of the agricultural holdings and the registered agricultural producers has different dynamics (Figure 16). In 2010 and 2016, the number of persons consulted represented respectively slightly above and slightly below 10% of the total number of agricultural holdings in the country (compared to nearly 8% in 2013). During the same period, the proportion of the consulted persons in the number of registered agricultural producers dropped sharply from close to 57% to just under 20%. The NAAS does not limit its consultations to only certain groups of agricultural producers (registered, small, etc.), and the number of different groups is not constant - the total number of holdings is constantly decreasing, the number of registered producers is increasing, etc.

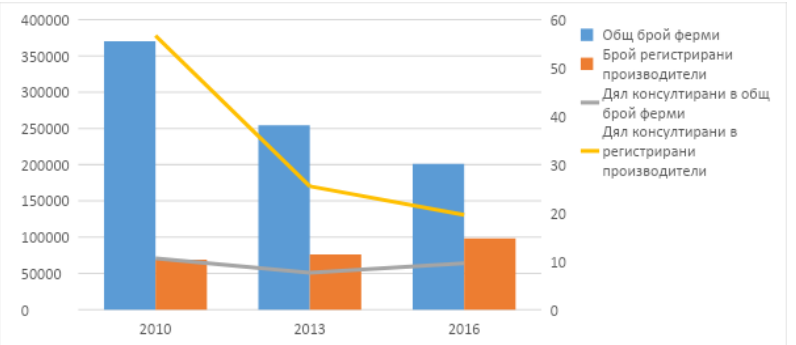

Figure 16. *Share of consulted persons by NAAS in the total number of agricultural holdings and registered agricultural producers*
Source: Годишни отчети за дейността на НССЗ, Агростатистика, МЗХ

Although approximate, the above proportions give an idea of the scope of agricultural producers covered by the consultancy services of NAAS. In 2017, about 17% of all registered agricultural producers were consulted and nearly 10% of the total number of farms in the country. This can be considered a great achievement given the number of the farmers and the experts of NAAS.

Compared to 2009, the number of consultations per consultant increased almost 4 times to 5.8 in 2017 (Figure 17). This is a result of both a steady increase in the consulting needs of farmers as well as a longer, better and more diverse service provided by the NAAS.

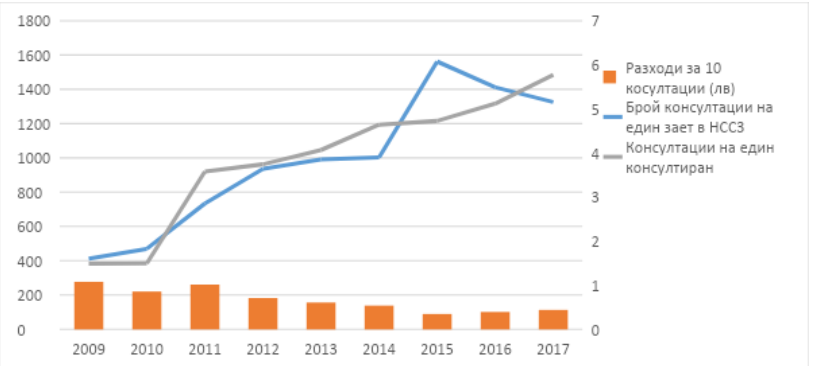

Figure 17. *Number of consultations per employee at the NAAS, consultations per consulted person, and costs per one consultation*
Source: Годишни отчети за дейността на НССЗ

As a result of the increased experience, qualification and productivity of the NAAS staff, the cost of one consultation has been significantly reduced over the period (Figure 17). All this testifies to the continuous improvement of the organization and to the increase of the efficiency of the consulting work and the activity of the NAAS.

The analysis of the various persons consulted according to the type of their farming in recent years shows that those who have not yet set up a farm and do not cultivate land or raise animals occupy a dominant share (Figure 18). Moreover, after 2012, the number and relative share of the potential farmers, which in 2015 increased, represent 44% of all consulted persons. The later confirms the important role of the NAAS in advising new entrepreneurs in agriculture.

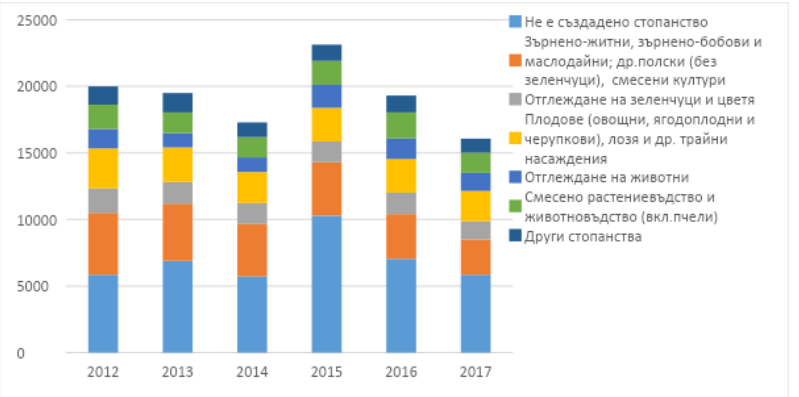

Figure 18. *Number of consulted persons by NAAS according to the type of agricultural activity performed*

Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

Producers of cereal, beans and oilseeds, other field crops (excluding vegetables) and mixed crops are the largest group of farmers involved in the consultations of NAAS. During the analyzed period their number and relative share decreased significantly, accounting for 16% of all consulted in 2017.

The second largest among consulted by NAAS is the group of farmers specialized in fruit production (including fruit, berries and nuts trees), vineyards and other perennials. Their share dropped slightly until 2015, after which it again increased to 14% of all consulted persons.

The consulted farmers involved in mixed crop and livestock (including bees) are the third largest group targeted by the NAAS consultations and their relative share is relatively constant over the period (9%). The relative share of the consulted farmers specialized in growing vegetables, flowers and animals is relatively small and constant over the period.

Most of the farms consulted are small in size (Standard production volume of up to EUR 8000) - over 90% in the last few years (Figure 19). The economic size of most of these

farms is very small (up to 2000 euros) and they are essentially "semi-market" producers.

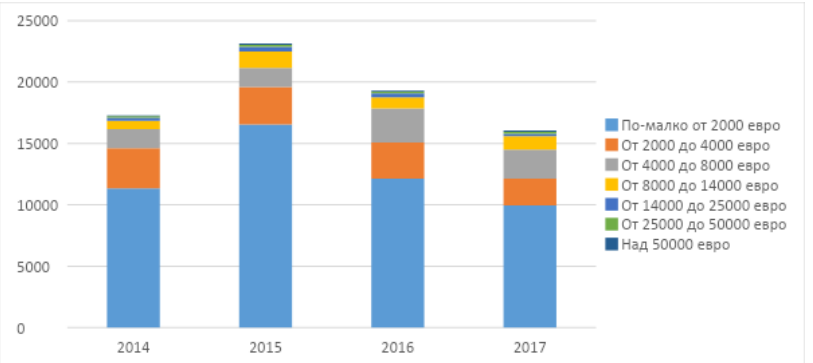

Figure 19. *Number of consulted persons by NAAS according to the size of holdings in Standard Production Volume*

Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

The large-sized farms have their own specialists (agronomist, etc.) and/or the ability to hire outside private consultants and to a small extent use the services of the NAAS. The number of large farms consulted (over € 25,000) is small, but their relative share increases up to 1.8% over the period. This proves that NAAS has the capacity and manage to serve the needs of all types of farmers.

The farms of different size groups in the country receive to a various degree consulting services from the NAAS. In 2016, the largest proportions of consulted farmers are in the total number of small market-oriented farms in the country, with a Standard production volume of EUR 4,000 to 8,000 (just over 12% of them) (Figure 20). They are followed by the small semi-subsistence farms (up to EUR 2,000) and those ranging from EUR 2,000 to 4,000, with slightly less than 12% and slightly more than 8%, respectively, receiving consultations from the NAAS.

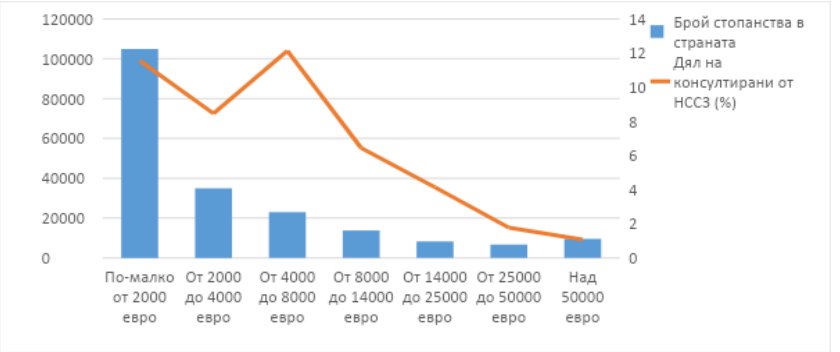

Figure 20. *Total number of holdings with different Standard production volume and the share of farmers consulted by NAAS in the respective group (2016)*

Source: Годишни отчети за дейността на НССЗ, Агростатистика, МЗХ

These conclusions are also confirmed by the analysis of the number of persons consulted according to the size of the cultivated land. The majority of the farms consulted manage up to 5 dka[3] of agricultural land, followed by the farm group of 10 to 50 dka (Figure 21). These groups consist mainly of small producers of crop and livestock produce. At the same time, the share of large farms with more than 500 dka is negligible during the period - between 0.7% and 1%.

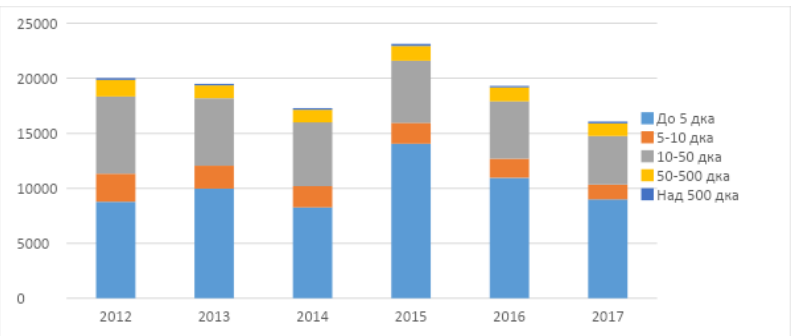

Figure 21. *Number of consulted persons from NAAS according to the size of the managed land*

Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

[3] 1 dekar (dka) = 0.1 ha

In 2013 and 2016, a significant and growing share of all small farms in the country (up to 1 ha of utilized agricultural land) received consultations from the NAAS - 6.6% and 9.8% respectively (Figure 22). In addition, a significant and growing number of farmers from small and medium-sized holdings (from 1 to 50 ha of UAA) have been consulted by NAAS during these years - 7.8% and 9.2% respectively. In the same period, only about 1.5% of all large holdings in the country (over 50 ha) received consultations from the NAAS.

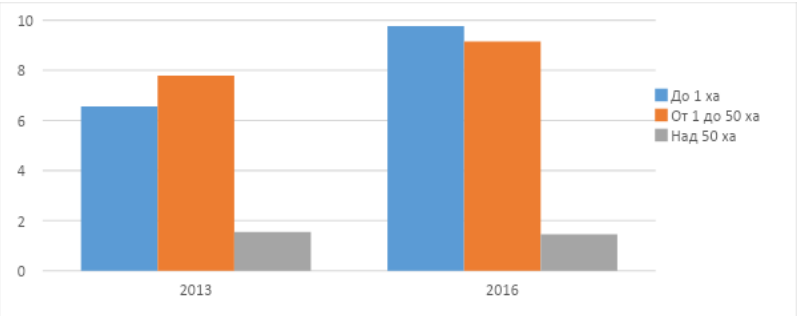

Figure 22. *Share of consulted farmers by NAAS in the total number of holdings with a certain size of managed land (%)*
Source: Годишни отчети за дейността на НССЗ, Агростатистика, МЗХ

Along with the evolution of the needs of agricultural producers, the theme (subject) of the consultations provided by the NAAS has been progressively developing. The consultations regarding the possibilities for supporting the farms with the measures of the Rural Development Programs dominate followed by the specialized consultations, other consultations and consultations related to direct payments (Figure 23).

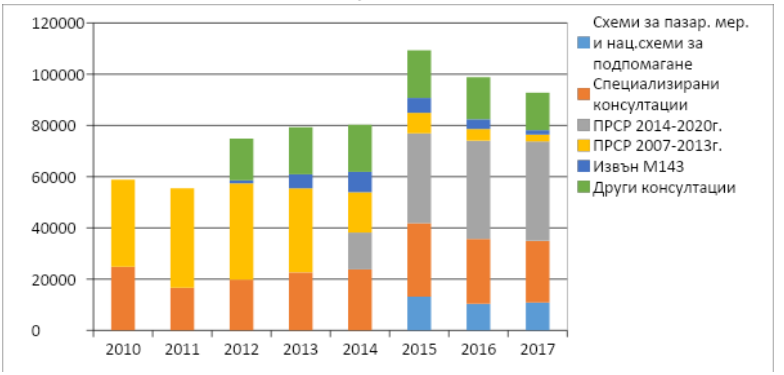

Figure 23. *Number of consultations by NAAS according to their topic*
Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

In the first thematic group, the most consultations in the last years have been provided for sub-measure 6.3 "Start-up aid for the development of small farms", 6.1 "Start-up aid for young farmers", sub-measure 4.1.2. "Investments in agricultural holdings" under the Thematic Sub-Program for the Development of Small Farms and the measure "Organic agriculture" (Figure 20). In the last three years, special attention has also been paid to consultations related to the National Climate Change Action Plan 2013-2020 and river basin management plans, in relation to the Water Framework Directive and the Water Act.

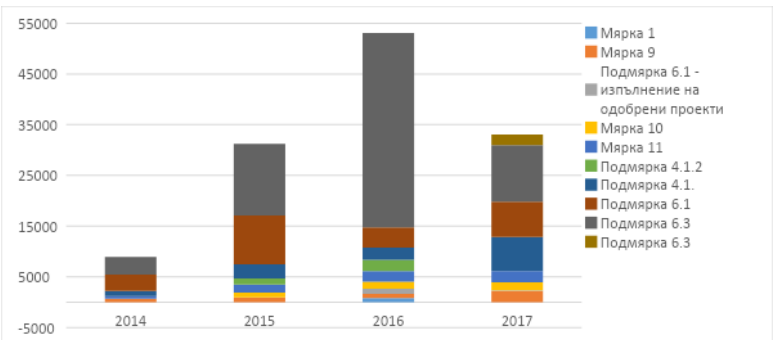

Figure 24. *Number of consultations provided by NAAS related to the various measured of RDP*
Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

In the volume of specialized consultations those in the field of crop production and agrarian economy dominate, as their share varies in each year during the period 2009-2017 respectively from 25% to 39% and from 25.6% to 38% (Figure 25). This is undoubtedly related to the dynamically changing regulatory, market and natural environment, which requires intensive consultations with experts.

Livestock consultations are the third most important in this thematic group, with their number and relative share decreasing over the period (from 23% to 14%).

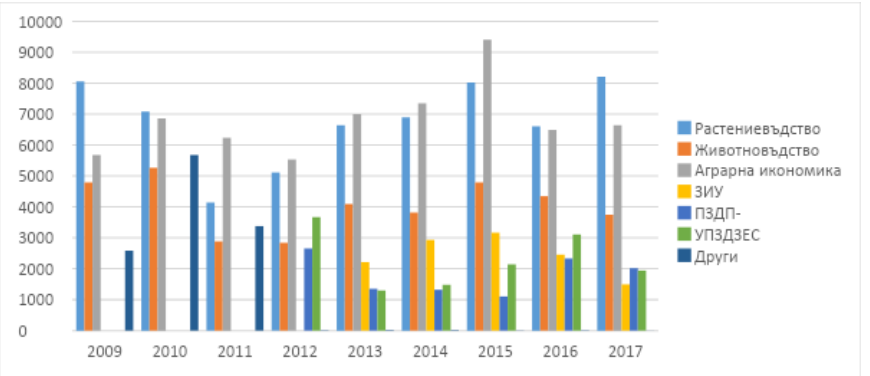

Figure 25. *Number of specialized consultations by NAAS*
Source: Годишни отчети за дейността на НССЗ, Аграрни доклади

Furthermore, NAAS also uses other effective forms of dissemination of knowledge and innovations in the sector. For the period 2007-2017 as many as 2,979 farmers and other persons were trained in the various long and short-term courses at the Center for Vocational Training at the NAAS. The trainings provided were funded with the European and national funds under the Operational Program "Human Resources Development" under measure 111 "Vocational training, information activities and dissemination of scientific knowledge" by the RDP or without external funding, and they are free of charge to farmers.

In 2014, the NAAS completed the trainings under measure 111 "Vocational training, information activities and dissemination of scientific knowledge", and no courses were conducted under measure 1 "Transfer of knowledge and information actions" of the RDP 2014-2020. Therefore, in 2017, only two training courses were conducted on "Agroecology" and "Training on major environmental issues in agriculture", with a total of 41 farmers and 5 experts trained (НСС3).

In addition, NAAS organizes hundreds of different events each year related to the transfer and dissemination of knowledge and innovations - information meetings, seminars, demonstrations, consulting days, etc. (Figure 26). Information meetings have taken a major share, which has expanded in recent years. Since 2016, a combined organization of seminars with demonstrations has been implemented, which is more effective in disseminating knowledge and positive experiences than conducting it separately.

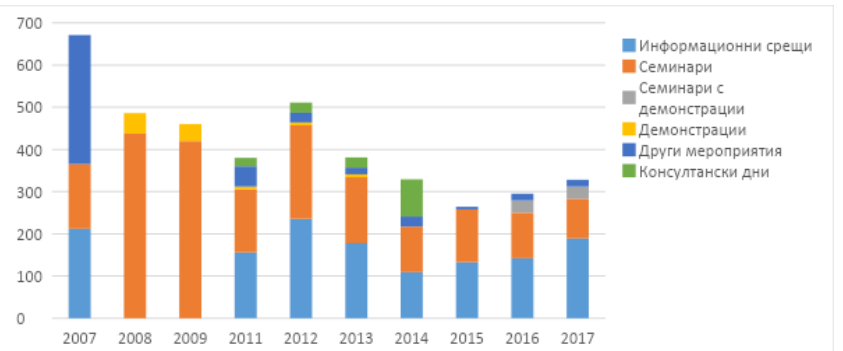

Figure 26. *Number and type of events organized by NAAS*
Source: Годишни отчети за дейността на НСС3

A large part of the NAAS activities is organized jointly with leading AA scientific institutes, agrarian and other universities, development and other organizations and

individual experts or teams. For example, in 2017, joint activities and activities of the NAAS with universities, scientific institutes, and other organizations were one-third of the total and more than 2 600 farmers participated in them (НСС3). Collaborative events are very popular with farmers and, by their nature, are specialized one-day training.

In the period after 2010, the number of events conducted by the NAAS, the total number of participants in them, and the average number of participants per event varied from year to year and tend to decrease. (Figure 27). For example, in 2017, nearly 11,000 were participants in 328 events, with an average of just over 33 people per event. The reduced number of participants in a single event enables the improvement of communication and exchange of knowledge and experience between experts and farmers and between the participants themselves, a greater adaptation to the specific needs of the participants and increased efficiency.

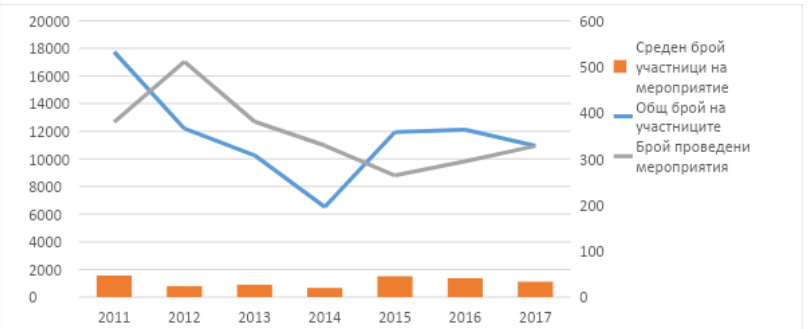

Figure 27. *Number of events organized by NAAS and participants*
Source: Годишни отчети за дейността на НСС3

Since 2015, the NAAS has introduced a new form of dissemination of information to farmers through the so-called. "Farmer circles". The purpose of the 27 farming circles set up in each region is to increase the efficiency and reach to more farmers through consultations, advices, dissemination and sharing of useful information, promotion of good

practices for applying and implementing RDP projects, etc. The total number of farmers participating in these circles is around 315 and varies widely in the different regions - from 6 (Blagoevgrad) to 23 (Varna).

The NAAS produces and disseminates hundreds of information materials (educational leaflets, farmer calendars, brochures, etc.), the number of which is steadily decreasing (from 731 in 2009 to 143 in 2017). At the same time, the use of effective modern forms of communication such as the Internet and the media is increasing. NAAS website, which contains diverse up-to-date information about the activity, a library with useful tips in various fields, etc. Demonstrates a steady increase in visits (including from abroad). NAAS experts also make numerous media appearances, reaching numerous audiences by publishing articles, giving interviews in the national and local press, appearing in national, regional and local radio and television broadcasts, Internet publications, etc.

The NAAS experts are also constantly participating in forums organized by other organizations in the knowledge and innovation sharing system at home and abroad. It is also active in the preparation and participation in projects with neighboring and other European countries to improve capacity, coordination and cooperation of activities, exchange of knowledge, experience and innovations, etc.

An informal Advisory Council is also put in place to improve the service activity to farmers at each territorial office of the NAAS. This form allows for effective discussions with farmers, professional organizations, scientific institutes and representatives of the local state structures on how to improve the activities of the respective office. All of this contributes to increasing the efficiency of the NAAS in transferring, disseminating and sharing knowledge and innovations.

Agricultural and other universities, AA institutes and stations, producer organizations, various non-governmental organizations, etc. also provide training and provide a wide range of advices to farmers. In addition, with a similar or complementary (as part of a marketing and production strategy) activity are also involved numerous organizations and individuals from the private sector - suppliers of seeds, chemicals, machinery and technologies, agricultural processors, specialized firms for training, consultations and innovations, and the farmers themselves. In this way, farmers receive such services for free, in a "package" with the main commercial activity of suppliers and/or buyers, or share and/or trade with each other. However, in the country there is no systematic reporting, statistical or other information on the rapidly developing and extensive university and private sector of training and consulting.

Expert assessment on the state of agricultural information, training and advices system

Most experts believe that the level of public spending and investments for the introduction of agrarian innovations (62.5%), and for agricultural advice and training (43.7 %) is low or very low (Figure 28).

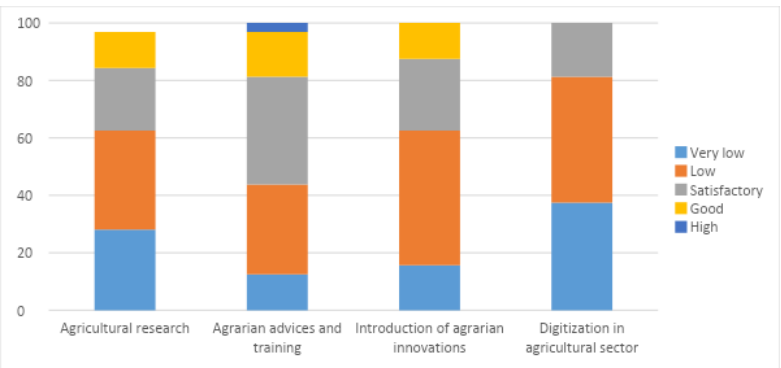

Figure 28. *Level of public expenditure and investment in AKIS (%)*

A relatively small number of experts consider the costs of the diverse components of the AKIS to be satisfactory, with a larger share of public expenditure and contributions to agrarian advices and trainings. However, none of the experts consider the level of expenditure and investment is high in agrarian research, and the introduction of agrarian innovation, and only a small fraction considers them to be high in agrarian advice and training. Therefore, public expenditure and investment for the development of all these important areas of the AKIS are to be significantly increased so that the main objectives of the CAP can be achieved in the next programming period.

As far as the efficiency of public resources for agrarian advices and training is concerned, the majority of experts believe that it is good or high (37.5%) (Figure 29). This proves that the comparatively higher level of public support in this area also gives comparatively higher efficiency. At the same time, however, for a small number of experts, the efficiency of public spending and investment in agrarian advice and training is satisfactory (31.2%) or low (28.1%). Therefore, work is to be continued to raise the efficiency of public investment in this important area.

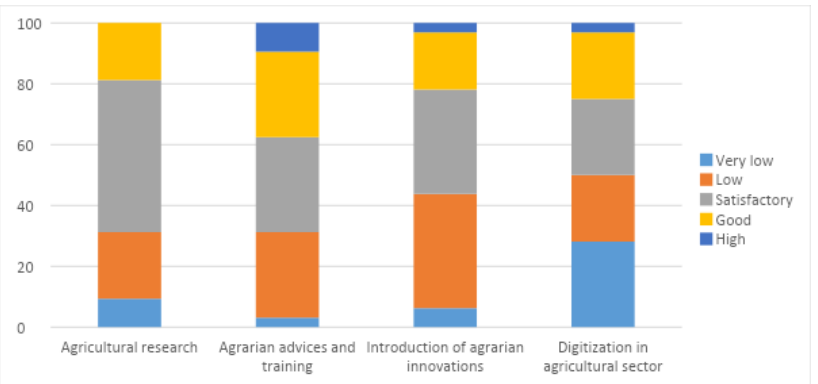

Figure 29. *Efficiency of public expenditures and investments in AKIS (%)*

According to the majority of the experts (43.7%), the efficiency of public investments for the introduction of agrarian innovations is low or very high. However, a significant proportion of them rate the efficiency of this type of public support as satisfactory (34.4%). Moreover, for almost 22% of the experts, public spending and investments for the implementation of agrarian innovations are of good or high efficiency. The later indicates that limited investment in this area is of high efficiency and are to be increased, as there is a great potential for improving efficiency through additional investment.

Experts are largely unanimous that the most important "providers" of new information to farmers are research institutes (84.4%), universities and NAAS (78.1% each), private companies and consultants (71.9%), the media and Internet (68.8%), non-governmental organizations (65.6%) and producer organizations (62.5%) (Figure 30). A considerable number of experts also believe that important suppliers of new information to farmers are retail chains (40.6%), processors (37.5%), foreign organizations (37.5%), and wholesalers and exporters (34.4%).

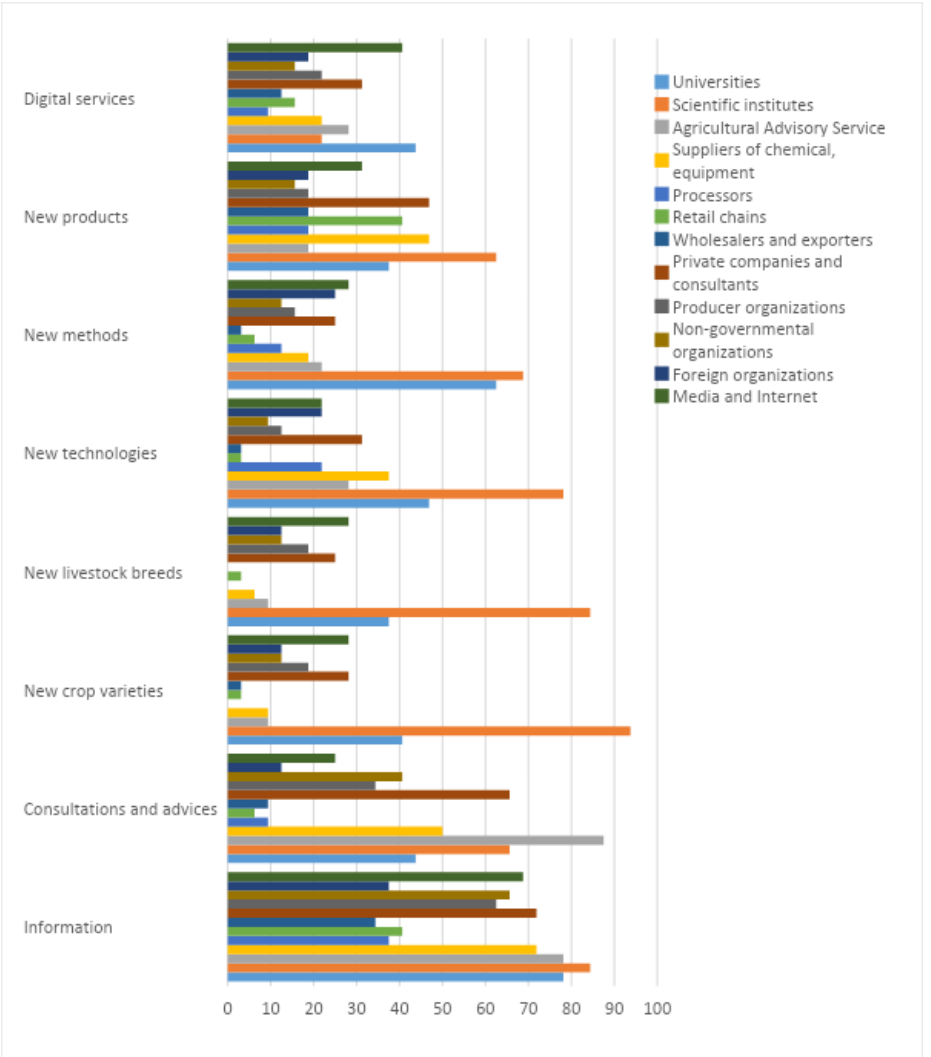

Figure 30. *The most important organizations providing agricultural farms with information, advice, innovations and digital services (%)*
Source: Experts assessment

The experts are also almost unanimous that the NAAS is the most significant provider of consultations and advices for Bulgarian farms (87.5%). Other important organizations for providing consultations and advices to producers in the

sector are research institutes and private companies and consultants (65.63% each). Every second expert also believes that suppliers of chemicals, equipment, etc. are among the most active in providing the necessary consultations and advices to their actual and potential clients. For a good number of experts, the universities (43.8%), non-governmental organizations (40.6%), producer organizations (34.4%), media and Internet (25%) are among the most important organizations providing agricultural consultations and advices in the country. The importance of other types of organizations is less in providing farmers with consultations and advices.

With regard to new plant varieties, the vast majority of experts (93.8%) identify research institutes as the most important organizations providing this type of innovations to agricultural farms. Many experts also identify universities (40.6%) as a major supplier of new plant varieties to farmers. A relatively large proportion of all experts (28.1%) also consider that private companies and consultants, and the media and internet are important in providing information on/or supplying new varieties of plants.

With regard to new breeds of animals, the situation is similar to that of new plant varieties, with experts ranked as the most important research institutes, followed by universities, the media and Internet, and private companies and consultants. A considerable number of experts (18.8%) also consider that producer organizations are among the most significant suppliers of new breeds of animals to farmers.

Regarding the provision of new technologies to the farms, research institutes are again ranked by the majority of experts (78.1%), followed by universities (46.9%), suppliers of chemicals, machinery, etc. (37.5%), private companies and consultants (31.2%), and NAAS (28.1%). A considerable proportion of experts (21.9%) also place foreign

organizations, the media and internet among the most important in providing information, assistance or direct supply of new technologies.

According to the majority of experts, the most important organizations providing new methods of production and management for farmers are research institutes (68.8%) and universities (62.5%). A relatively large proportion of experts also place the media and Internet (28.1%), private companies and consultants, foreign organizations (every fourth) and the NAAS (22.9%) among the most significant organizations in providing information on /for new methods of production and management in the sector.

The most important for the presentation to the farmers of new products are scientific institutes (62.5%), private companies and consultants (46.9%), suppliers of chemicals, equipment, etc. (46.9%), retail chains (46.9%), and universities (37.5%). A significant number of experts also put media and Internet (31.3%), NAAS, processors of farm produce, wholesalers and exporters, producer organizations and foreign organizations (18.8% each) as important in product innovations.

With regards to digital services and innovations, the universities (43.8%), and media and Internet (40.6%) are pointed by the majority of experts as most important to farmers' organizations. For a good number of experts, among the most significant providers of digital information and services, are also private companies and consultants (31.2%), NAAS (28.1%), scientific institutes, suppliers of chemicals, equipment, etc., and producers organizations (21.9% each).

According to the experts the highest financial endowment of agricultural research and consulting is in the private companies and organizations, where, according to nearly 63% of experts, it is good or high (Figure 31). At the same time, financial endowment of agrarian research and

consultancy at scientific institutes and stations is estimated by almost 69% of experts as unsatisfactory. The later shows that the profit-oriented private sector invests more in financial resources in these important activities comparing to the public scientific institutes that dominate in the sector. Therefore, the financial support to public research institutes is to be increased in order to reduce the existing imbalance with the private sector.

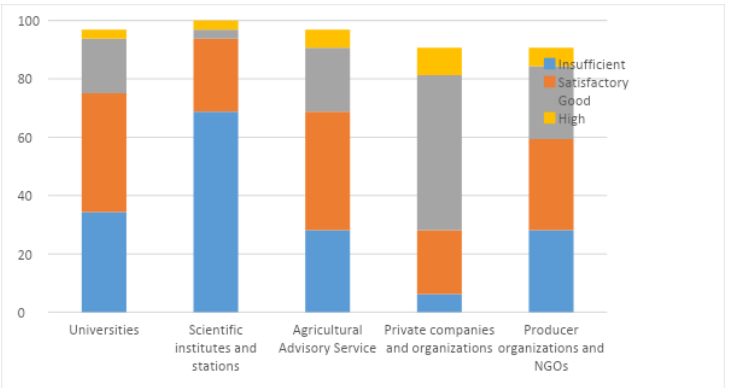

Figure 31. *Financial endowment of agrarian research and consultations in the main organizations of the AKIS (%)*
Source: Experts assessment

The majority of experts believe that the endowment of research and consultations with financial resources in the universities and NAAS is satisfactory (40.6%). Moreover, a considerable number of experts evaluate that these activities of the NAAS and the universities are with good or high financial endowment - 28.1% and almost 22% respectively. The financial support for agrarian research and consultations of the non-profit-making producer organizations and non-governmental organizations was rated as satisfactory (31.2%) or unsatisfactory (28.1%) by most experts.

Universities are with the best staff endowment for agrarian research and consultancy, where, according to

nearly 69% of experts, it is good or high (Figure 32). Every second expert also believes that staffing for research and consultations of NAAS, and private companies and organizations is good or high.

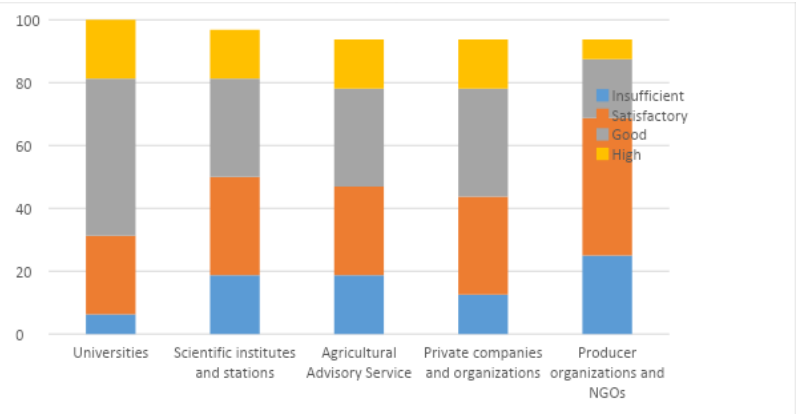

Figure 32. *Staff endowment of agrarian research and consultations in major organizations of AKIS (%)*
Source: Experts assessment

At the same time, the majority of experts estimate that the staffing of agricultural research and consultancy in scientific institutes and stations as satisfactory or good (31.2% each), and that of producer organizations and non-governmental organizations as satisfactory (43.8%). This calls for urgent measures to improve the incentives to attract new staff and to improve the skills of existing staff in the state and non-governmental agrarian research and consultancy sectors.

There is also considerable differentiation in the availability of advanced agricultural research and consulting equipment in different types of organizations (Figure 33). While in private companies and organizations it is good or high (59.4%), in scientific institutes and stations every second expert rates it as unsatisfactory, and only 31% as good or high. This proves the need to significantly modernize the

equipment of the public scientific institutes that dominate the sector.

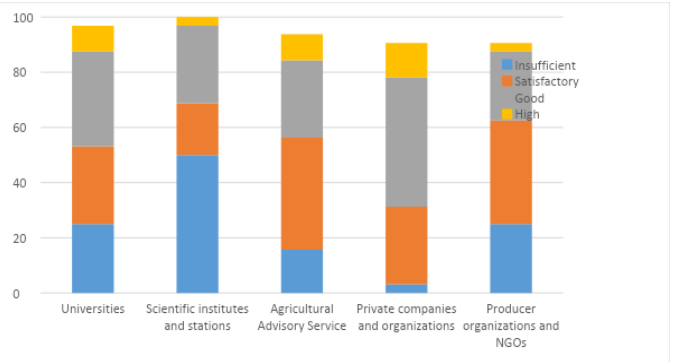

Figure 33. *Endowment with modern equipment of agrarian research and consultations in major organizations of AKIS (%)*
Source: Experts assessment

The majority of experts believe that the availability of modern equipment in NAAS is satisfactory (40.6%), and not many who rate it as good or high (37.5%). The material endowment of this type of activities of the producer organizations and non-governmental organizations was evaluated by the majority as satisfactory (37.5%). At the same time, however, every fourth expert thinks that it is either unsatisfactory or good. The later indicates for the different material capacities of the individual non-profit-making organization, and the needs to take public action to support those lagging behind.

Despite the inadequate and quite divers endowment with financial, human and material resources, the public agricultural research and consultation system demonstrates high potential for modern agricultural research and consultations. According to the majority of experts, the potential of universities, research institutes and stations, as well as the NAAS for modern agrarian research and consultations is good or high - 65.6%, 65.6% and 50%

respectively (Figure 34). This indicates that public organizations in agricultural research and consultations will continue to dominate in the future and have to receive increasing public support.

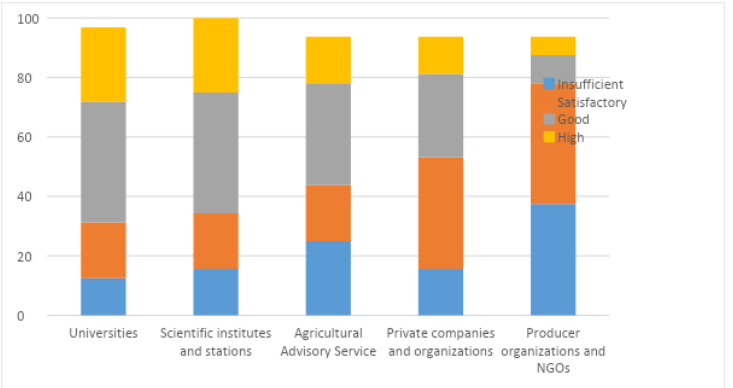

Figure 34. *Potential for modern agrarian research and consultations in major organizations of AKIS (%)*
Source: Experts assessment

On the other hand, the potential for modern agrarian research and consultations in the private sector has been identified as satisfactory - by 37.5% of experts for private companies and organizations, and by 40.6% for producer organizations and non-governmental organizations. Along with this, however, nearly 41% of the experts believe that the potential of profit-oriented private companies and organizations for modern agricultural research and consulting is good or great. This shows that with effective public support and regulation, the role of the private sector in agricultural research and consultations will be expanded in the future and has to be a priority.

The majority of experts regard the links between the universities and scientific institutes, scientific institutes and NAAS, NAAS and farmers, NAAS and producer associations, producer associations and agricultural

producers, private companies and consultants and farmers as highly effective (Figure 35).

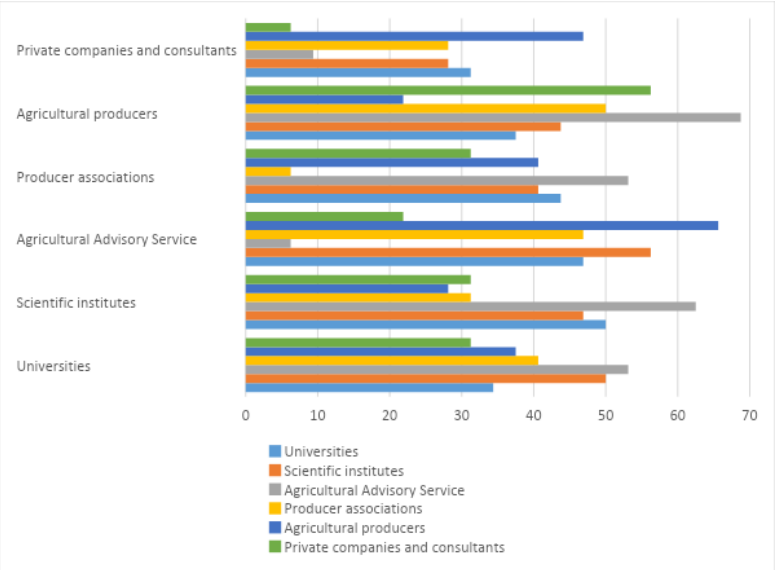

Figure 35. *Efficiency of links between organizations in AKIS (%)*
Source: Experts assessment

At the same time, some important links for the development of the AKIS are not identified as effective by experts - between individual universities, universities with farmers and private companies and consultants, scientific institutes with farmers and private companies and consultants, NAAS with private companies and consultants, producers' associations among themselves and with private firms and consultants, between private firms and consultants, and between farmers themselves. Also, only 46.9% of the experts are convinced that the links between the scientific institutes themselves are highly effective, which is not a good indicator of the degree of integration and coordination of the activities of the various scientific institutes in the country.

In order to improve all these critical links for the development of the AKIS, effective measures are to be taken immediately from the leadership of the public sector organizations, as well as adequate incentives for participants and public support introduced though state funding, tax relief, logistics, assistance, regulations, networking, etc.

According to a large part of the panel of experts, farmers in the country have good or great access to new information (56.3%), consultations and advices (65.6%), new plant varieties (56.3%), new breeds of animals (43.8%) and new technological innovations (50%) (Figure 36). Therefore, in these areas, the existing AKIS works relatively well and serves farmers effectively.

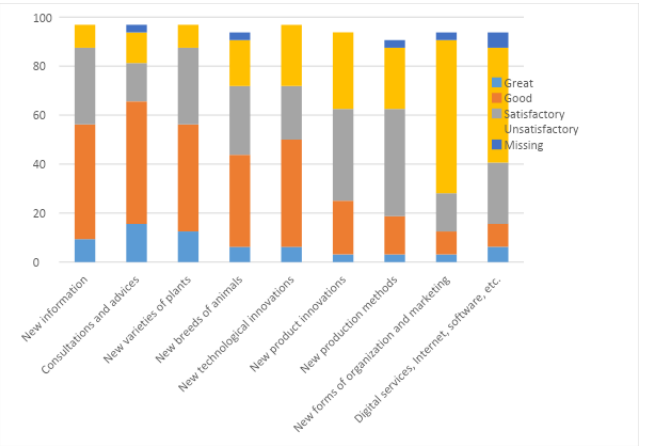

Figure 36. *Extent of access of agricultural producers to information, consultations, innovations, and digital services (%)*
Source: Experts assessment

At the same time, however, the majority of experts assess that producers' access to new product innovations and new production methods is satisfactory (37.5% and 43.8% respectively) or unsatisfactory (31.3% and 25%). The most unfavorable situation is the access of farmers to new forms of organization and marketing, which is estimated by a

significant number of experts as unsatisfactory (62.5%). Therefore, public measures are to be taken to support and encourage the participants in the AKIS in order to improve the supply and market development of diverse types of innovation in the country.

The situation with the farmers' real access to digital services, internet, software, etc. is also unfavorable. Just over 53% of the experts consider this access to be inadequate or nonexistent, with one in four assessing it as satisfactory. Cardinal public support measures (investments, training, incentives, partnerships with the private sector, etc.) are to be also undertaken in this important area in order to overcome the lag in the digitalization of the agricultural production and rural areas of the country.

There is considerable differentiation in the degree of use of advices and consultations, and in the introduction of innovations of different kinds in individual sub-sectors of agriculture, in farms of different legal types and sizes, and in different regions of the country. According to the experts, the most widely advices and consultations are used in vegetable production (34.4%), field crops (31.3%), fruit growing (28.1%) and animal husbandry (28.1%) (Figure 38). At the same time, only a small number of experts believe that the other sub-sectors of agriculture benefit greatly from the advices and consultations provided by various public and private organizations.

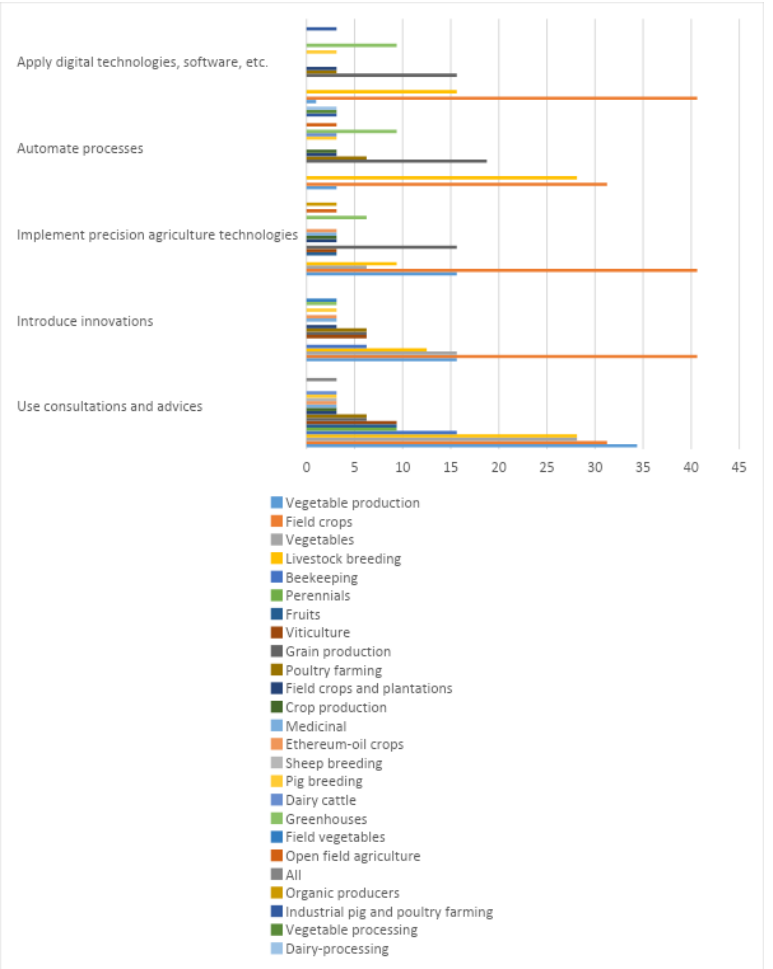

Figure 38. *Extent of utilization of advices and consultations, and introduction of innovations of various type in individual subsectors of Bulgarian agriculture (%)*
Source: Experts assessment

There is also a great variation in the extent to which advices, consultations and innovations are introduced on farms of different types. According to the majority of experts, Physical Persons (48.9%) use to the greatest extent advices and consultations (Figure 39). Just over 31% of the experts also indicated that advices and consultations was

widely used by agricultural producers. According to the majority of the experts' panel, other juridical types of farms make little use of the advices and consultations provided by various public and private organizations.

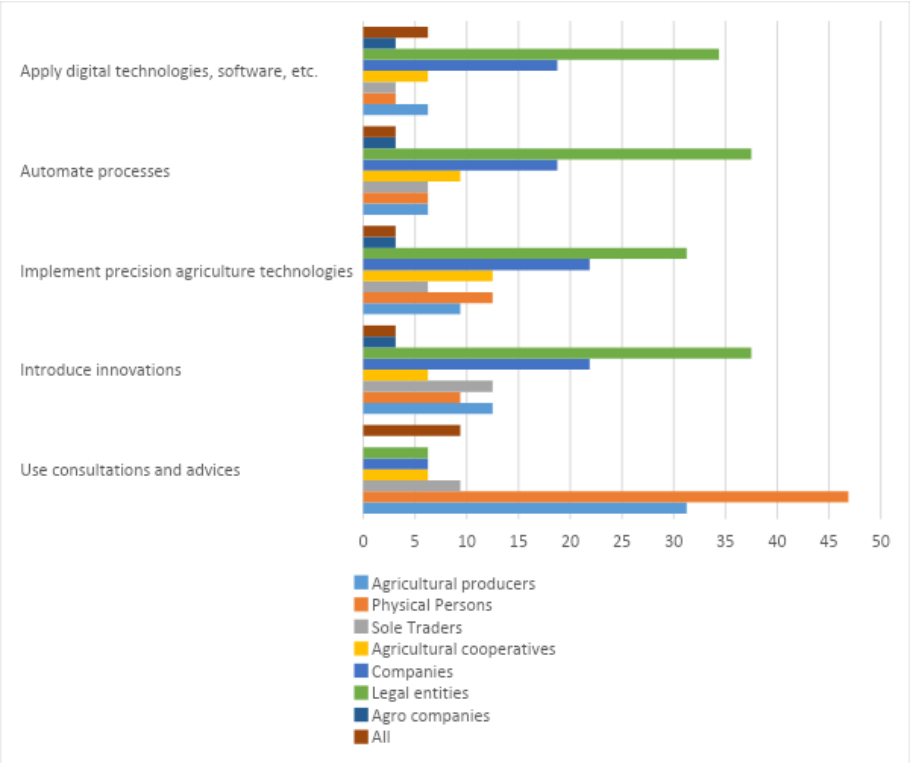

Figure 39. *Extent of usage of advices, consultations, and introduction of various kind of innovations in agricultural farms od different juridical type (%)*

Source: Experts assessment

A significant number of experts consider that small farms use the most advices and consultations (71.9%), while other categories of producers use less "external" advices and consultations (Figure 40).

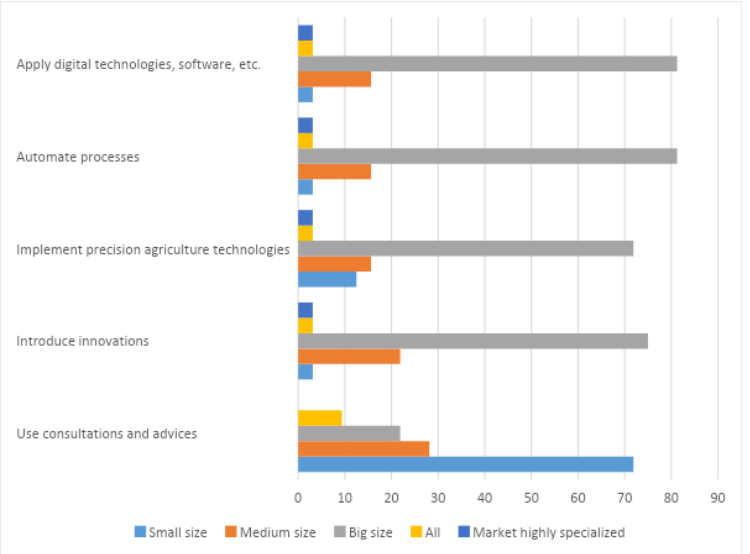

Figure 40. *Extent of utilization of advices and consultations and in the introduction of innovations of various type in agricultural farms of different sizes (%)*
Source: Experts assessment

Finally, there are differences in the degree of use of advices and consultations, and in the introduction of different types of innovation in different geographical regions of the country. According to one in four experts, advices and consultations are used evenly throughout the country (Figure 41). A considerable number of experts also points the North-East and South-Central regions of the country (18.8% each) as the largest users of advices and consultations.

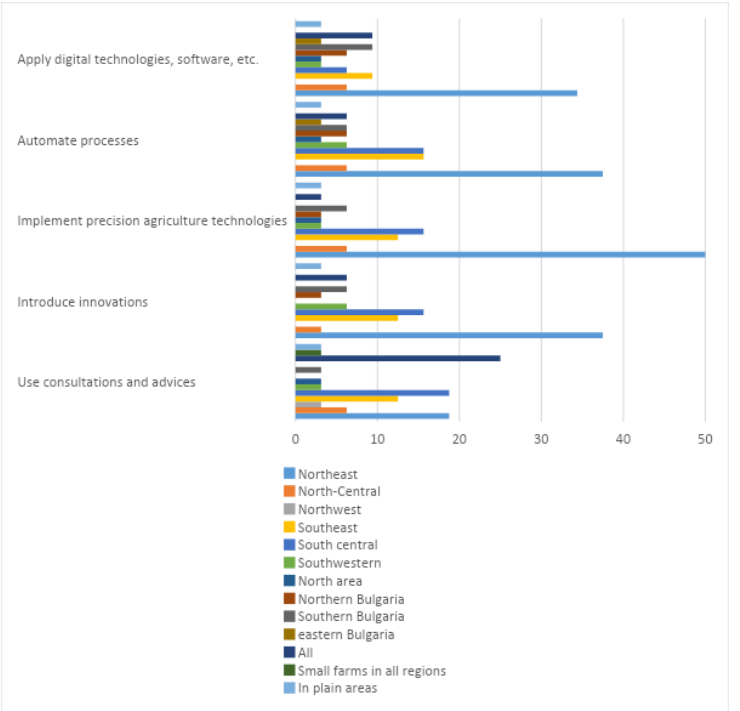

Figure 41. *Extent of utilization of advices and consultations and in introduction of innovations of various type in different regions of the country (%)*

Source: Experts assessment

Experts are very unanimous that the most important factors (of great or very great importance) for improving the dissemination of knowledge, innovation and digitalization in agriculture and rural areas of the country at this stage are: market (consumers) demand, prices, competition and subsidies for new investments (84.4% each), as well as the activity of the National Agricultural Advisory Service (81.3%) (Figure 42). Therefore, the support for market development is to be extended as well as of the public support (subsidies) for consultations and training, and for the private investments in the area.

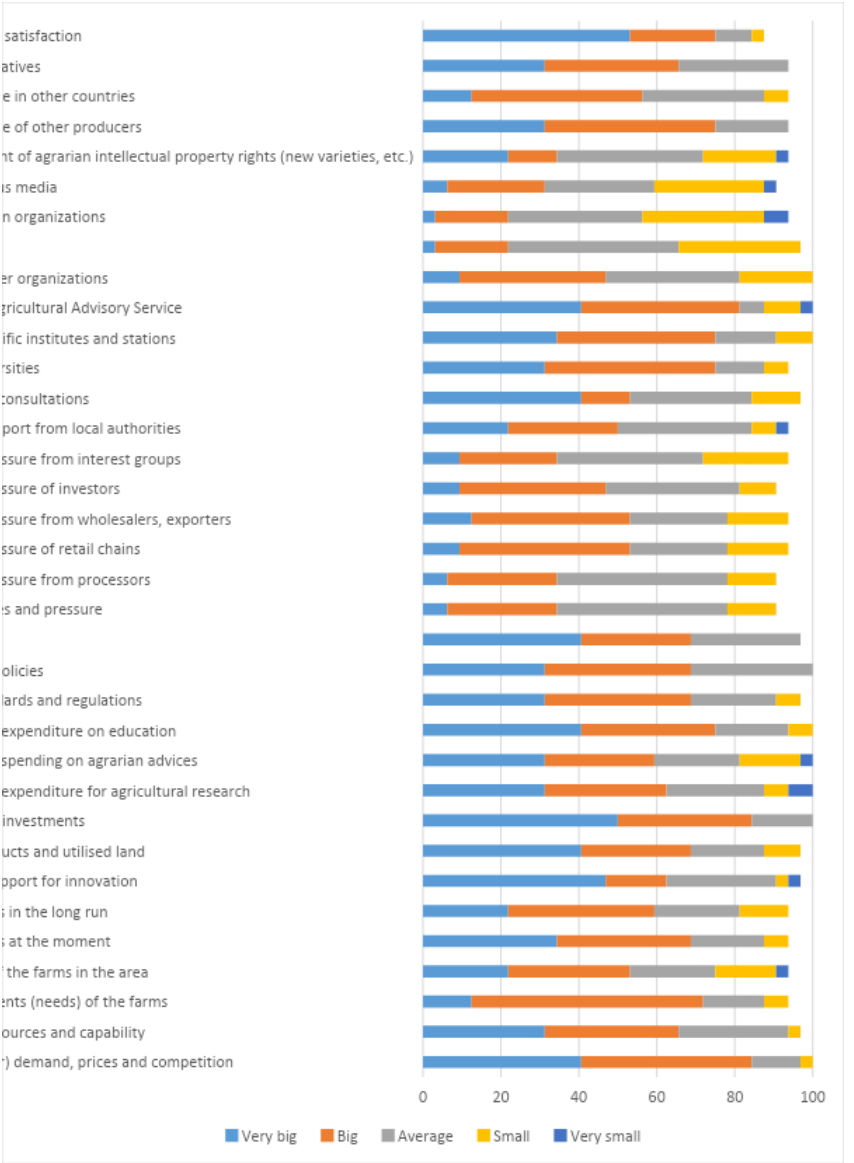

Figure 42. *Importance of various factors for amelioration of the dissemination of knowledge, innovations and digitalization in Bulgarian agriculture and rural areas (%)*
Source: Experts assessment

Three quarters of the experts also believe that the increase in public spending on education, the activities of universities, the activities of scientific institutes and stations, the positive experience of other producers, and farmers' personal satisfaction, are important factors for improving knowledge dissemination, innovation and digitalization in agriculture and rural areas.

A large number of experts also estimate that the specific requirements (needs) of the farms (71.9%), and the profit and the current benefits, subsidies for products and used land, regulations, standards and regulations, EU policies and policies of the state (68.8% each) are decisive for improving the diffusion of knowledge, innovations and digitization in agriculture and rural areas.

The majority of experts also give a high rank to the available resources and capability of the farms, and the farmers' own initiatives (65.6% each), as well as to the public financial support for innovations, and the growth of public expenditure on agricultural science (62.5% each), the long-term profits and benefits, and the rise in public spending on agrarian advices (59.4% each), the positive experiences in other countries (56.3%), and the effective access of farms and in the region, the initiatives and pressure of the retail chains, the initiatives and pressure on wholesale traders and exporters, and the free training and consultancy (by 53.1%) for improvement the situation in this respect. All these factors for improving the existing state are to be taken into account in the process of amelioration of the public support for the development of AKIS in the next programming period

Most experts believe that the successful achievement of the horizontal objective contributes to a large or very large extent to the achievement of all specific objectives of the EU CAP (Figure 43).

According to most experts, improving the dissemination of knowledge, innovations and digitalization of agriculture and rural areas contributes to the greatest extent to the achievement of the specific objectives of sufficient agricultural incomes and sustainability (81.3%), and enhancing market orientation and increasing competitiveness (78.1%).

On the other hand, a relatively smaller majority of the experts believe that improving dissemination of knowledge, innovations and digitalization in agriculture and rural areas contributes significantly to promoting employment, growth, social inclusion and local rural development (53.1 %).

All this proves that the effective measures are to be undertaken during the new programming period to realize the horizontal objective of the EU CAP for improvement of the dissemination of knowledge, innovations and digitalization in agriculture and rural areas, in order also to achieve successfully the specific objectives of the Union.

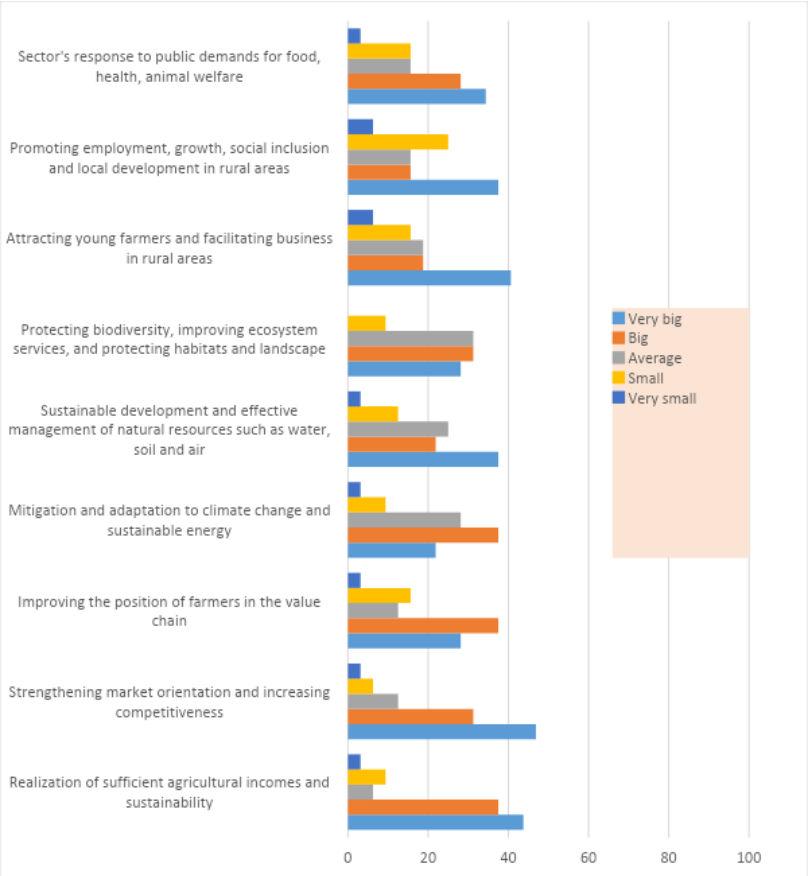

Figure 43. *Extent in which dissemination of knowledge, innovations and digitalization in agriculture and rural areas in Bulgarian contributes for achievement of different objectives of EU CAP (%)*
Source: Experts assessment

Conclusions

The agricultural training and advice system includes numerous actors for which diverse activities and relationships lack summarized information. As a result of the measures taken, the proportion of managers who have completed full agricultural training has increased since the country's accession to the EU, however, almost 93% of all agricultural managers are still with only practical experience

and no agricultural training. The participation rate in the rural regions remains weak and steadily decreasing, with Bulgaria being among the lagging EU member states in formal and non-formal education and training in rural areas.

Since our country's accession to the EU, the number of consultations provided by the NAAS has doubled, with 17% of all registered agricultural producers and every tenth farmer in the country consulted in recent years. The number of consulted is significantly reduced, which is a result of both the improving qualification level of farmers and the development of alternative forms of counseling. Along with the evolving needs of farmers, the topics of the consultations provided is evolving, with consultations relating to the possibilities of supporting farms with RDP measures occupying a predominant part.

The NAAS organizes hundreds of different events each year related to the transfer and dissemination of knowledge and innovations, many of which jointly with AA scientific institutes, agrarian and other universities, and other organizations, as well as individual experts or teams. The number of events held, the total number of participants and the average number of participants per event tends to decrease. New forms are being introduced to disseminate information to farmers through consultations on the farm, field offices, farmer circles, etc.

Financial and material resource endowment in the agricultural information, education and advices sector as well as the links between participants and with agricultural producers are have to further improved.

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